MODERN- PHYSIOLOGY.

II

Notesby.

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① Haemopoetic System:-

- ✓ Composition, function of Blood & Blood-cells.
- ✓ Haemopoiesis(Stages & devlopment of RBC, WBC, and platelets).
- ✓ Composition & functions of Bone-Marrow.
- ✓ Structure, types & functions of Haemoglobin.
- ✓ Mechanisms of Blood-clotting.
- ✓ Anti-coagulants.
- ✓ Physiological Basis of Blood groups.
- ✓ Plasma-Proteins.
- Introduction to Anemia & Jaundice.

Composition of Blood:-

Blood is a connective tissue in fluid form. Blood is mainly concerned with transport of nutrients & oxygen to the cells and transports metabolic waste products away from the body cells.

Blood is also called as-

1). Fluid of life:- as it carries O_2 from lungs to all body parts & CO_2 back to lungs.

2). Fluid of Growth:- as it carries the nutrients from the digestive system to the whole body.

3). Fluid of Health:- as it transports all the metabolic waste products from the body to the excretory organs.

Properties of Blood:-

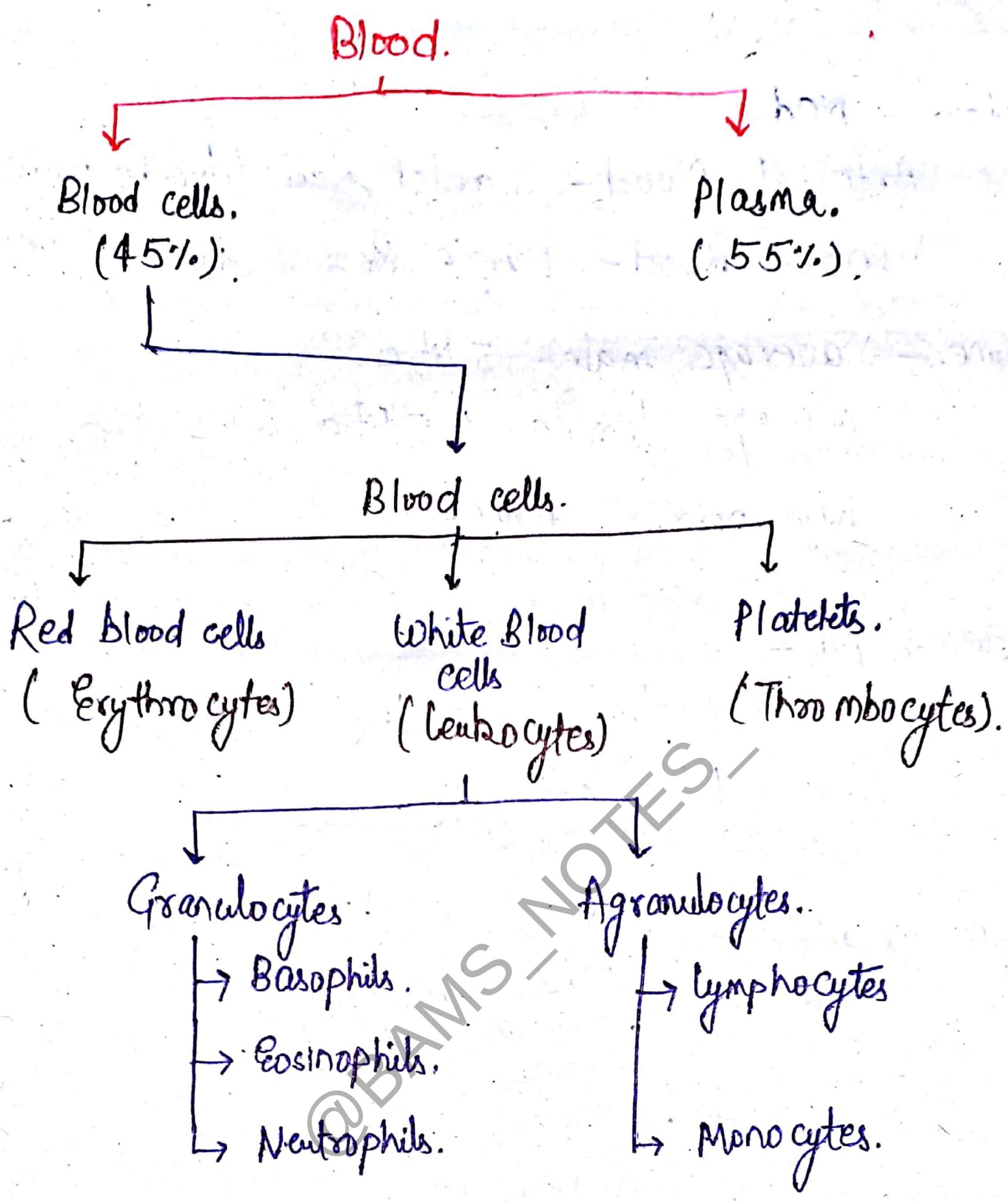
① Colour— Red.
Arterial Blood- Scarlet Red (due to more O_2).
Venous Blood- Purple Red (due to more CO_2).

② Volume:- average male- 5 litres.
average female- 4.5 litres.
New born- 450 ml.

③ Reaction & pH:-
Reaction - Alkaline.
pH— 7.4.

④ Specific Gravity:- 1.052-1.061.

⑤ Viscocity:- Blood is 5 times more viscous than water.


Blood.
Blood cells.
(45%).
Plasma.
(55%).
Blood cells.
Red blood cells
(Erythrocytes)
White Blood cells
(Leukocytes)
Platelets.
(Thrombocytes).
Granulocytes.
Basophils.
Eosinophils.
Neutrophils.
Agranulocytes.
Lymphocytes
Monocytes.

Plasma. (55% of Blood-volume).

Plasma.
- Water (92-93%).
- Solid (7-8%).
  - Inorganic Substances.
    - Sodium.
    - Calcium.
    - Pottasium.
    - Magnesium.
    - Bi-carbonate.
    - chloride.
    - Phosphate.
    - Iodide.
    - Iron.
    - Copper.
  - Organic Substances.
    - Plasma Proteins.
      - Albumin.
      - Globulin.
      - Fibrinogen.
    - Carbohydrates
      - Glucose.
    - Fats.
      - Triglycerides.
      - Cholestrol.
      - Phospholipids.
    - Hormones.
    - Urea
    - Uric Acid.
    - Amonia.
    - Creatinine.
    - Enzymes.
- Gases.
  - O_2
  - Co_2
  - N_2.

- Plasma is a straw (yellowish) coloured liquid part of blood. It contains 91-92% water & 8-9% solids.

Normal value of Important substances in Blood.

Blood Glucose.	100-120 mg/dL
Creatinine.	0.5- 1.5 mg/dL.
Cholestrol.	Upto 200 mg/dL.
Plasma Proteins.	6.4-8.3 g/dL.
Bilirubin.	0.5-1.5 mg/dL
Iron	50-150 µg/dL.
Copper.	100- 200 mg/dL.
Calcium.	9 - 11 mg/dL
Sodium.	135- 145 mEq/L.
Pottasium.	3.5 - 5.0 mEq/L
Magnesium.	1.5- 2.0 mEq/L
chloride	100-110 mEq/L
Bi- carbonate.	22- 26 mEq/L.

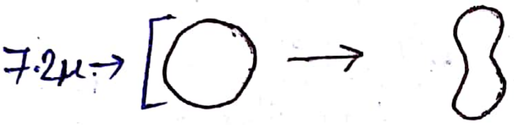
Blood- cells- (45% of Blood- volume).

① Red- Blood Cells. (Erythrocytes).

- RBCs are the non nucleated (without the nucleus), elements present in the blood. The red colour of RBCs is due to Haemoglobin.

Normal Value:- 4 - 5.5 million (40-55 lakh)/mm³ of blood.

Shape of RBCs:- RBCs are disc- shaped & bi- concave. (dumb-bell) shaped. The central part is thin & periphery is thick.



- Diameter of RBC is 7.2 microns; RBCs don't have Nucleus, Mitochondria, Golgi-Aparatus.

Life- span:- 120 days; after 120 days RBCs are destroyed in spleen.

Functions:-
① Transport of Oxygen.
② Transport of CO_2.
③. In Blood- group determination.
④ Acid-Base Balance.

Polycythemia:- Increase in Number of RBCs.

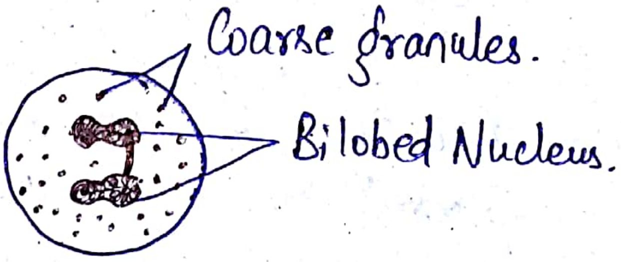
② White Blood-Cells (WBCs).

WBC/ Leukocytes are colourless & nucleated elements of blood. Primary function of WBCs; is to play an important role in defense mechanism of the Body.

Types:- On basis of presence of granules in cytoplasm. the WBCs are classified into.

WBC.
- Granulocytes
  - Basophils.
  - Eosinophils.
  - Neutrophils.
- Agranulocytes.
  - Monocytes.
  - Leukocytes.

① Basophils:-



Basophils are granulocytes c̄ bilobed nucleus & Coarse (Big) granules.

Size- 8-10 μ

Functions:-

- Basophils play an important role in Healing process; Basophils are also important in allergy/ acute Hyper- Sensitivity reaction.
- Basophils Secrete-

① Heparin- prevents intra-vascular blood- clotting.

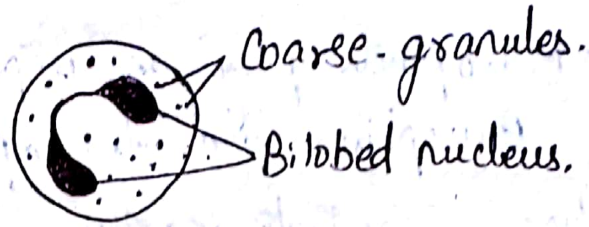
② Histamine/ Bradykinin/ Serotonin:- produces allergy by causing vascular & tissue Response.

③ Cytokine:- accelerates inflamation & kills invading organisms.

Normal value:- 0-2% of total WBC value.

Basophilia (↑ Basophils)	Basopenia (↓ Basophils).
① Small pox.	① Utricaria (खुजली).
② Chicken- pox.	②. Stress.
③ Polycythemia.	③ Prolonged chemotherapy.

② Eosinophils:-



- Eosinophils are granulocytes c̄ bilobed nucleus & coarse-nucleus.
- Size - $\boxed{10 - 14\,\mu}$

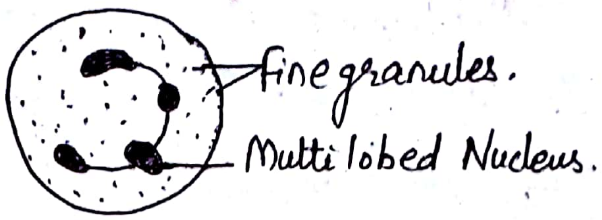
Functions:-

- Eosinophils play an important in protection of body against parasites;
- Eosinophilia (↑ in number) occurs during parasitic infestation & also during Asthma.
- Eosinophil granules produce cytotoxic elements to destroy the parasites; some of these are:-
  1. Eosinophilic peroxidase.
  2. Eosinophil derived Neurotoxin.

Eosinophilia	Eosinopenia.
①. Asthma	① Bactorial infection.
②. Malaria.	②. Stress
③. Filaria.	③ Prolonged use of steroids.
④. Intestinal parasites.	

Normal value - 1-6% of total WBC volume.

③ Neutrophils:-



Neutrophils/Polymorphs are granulocytes c̄ multilobed nucleus & smooth/fine granules.

Size - 10-12 μ.

Functions:- Neutrophils are the Ist line of Defense along c̄ monocytes.

Neutrophils are free cells & transport all over the body.

Mode of Action:-

Infection of micro-organisms.

↓

Release of Neutrophils.

↓

Phagocytic action.

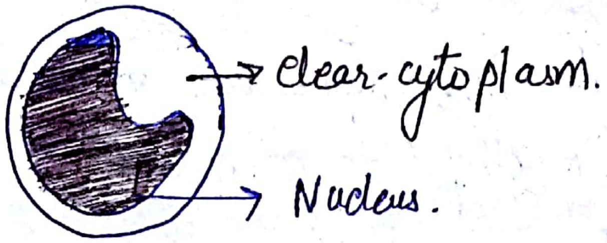
-Neutrophils first engulf the micro-organisms & then destroy them.

Normal value = 40-80% of all WBC volume.

Neutrophilia (↑).	Neutropenia (↓).
① Acute Infections.	① Bone marrow diseases.
②. Poisoning	② T.B.
③. foreign particle entry in body.	③. Typhoid
	④ Vitamin deficiency.

Agranulocytes.

① Monocytes:-



- Monocytes are Agranulocytes and also largest WBCs. Cytoplasm is clear, having no granules.
- Size- $\boxed{14-18\ \mu}$;

Functions:- Monocytes are the 1st line of defense along $\bar{c}$ neutrophils.

- Monocytes are Phagocytic in nature.

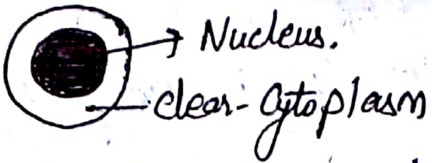
- When the monocytes leave the blood stream & enter the tissues, they are called Tissue Macrophages.

Examples-
① Kupffer cells in liver.
② Alveolar macrophages in lungs.
③. Macrophages in spleen.

Normal value 2–10% of Total WBC.

Monocytosis (↑).	Monocytopenia (↓).
① T.B.	① Prolonged use of steroids
②. Syphilis.	② AIDS.
③ Malaria.	

② lymphocytes:-



lymphocytes are agranulocytes, the nucleus is oval & ocupies most of the cytoplasm.

Size:- ① Large- lymphocytes - 10-12 μ.
② Small- lymphocytes - 7-10 μ

Function:- ① T- lymphocytes - Cellular-Immunity.
② B- lymphocytes - Humoral- Immunity.

~~Leukemia~~ → lympho-cytosis	lymphocytopenia.
① Diptheria	① AIDS
② Mumps	② Mal nutrition.
③ Rickets	③ Radio-Therapy
④ Syphlis.	
⑤ TB	
leukemia/ Blood cancer more than 1,000,000 leukocytes/mm³ of Blood.	

Normal values of WBC.

Total leukocyte Count (TLC):- 4,000-11,000 cells/ mm³ blood.

Differential leukocyte Count:-

Neutrophils.	50-70%.	3000-6000/mm³
Eosinophils.	2-4%.	150-450/mm³
Basophils.	0-1%.	0-100/ mm³
Monocytes	2-6%.	200-600/mm³
lymphocytes	20-30%.	1500-2700/mm³.

③ Platelets

; Platelets/Thrombocytes are the formed elements of the blood.

Structure:-

① Small (2-4μ diameter).
② colourless.
③ Non-Nucleated.
④ Spherical, Rod shaped, oval, disc-shaped.

Normal Count:- 2 lakh - 4 lakh/mm³ of blood.

Physiological Variations:-

① Platelets are less in infants (1.5 - 2 lakh/mm³) it reaches to normal value by 3rd month.

② No difference b/w male & female.

③ Platelets count increases on high altitude/ after meals.

Life-span & fate:- Average- life span of platelets is 8-11 days; after this time platelets are destroyed in spleen.

Functions.

Normally, platelets are inactivated & they activate due to some particular activators for eg

① Collagen-
②. Platelet activating factor

after activation platelets show following actions:-

① Role in Blood-clotting.

Platelets form the Intrinsic prothrombin activator which is responsible for onset of blood clotting.

② Clot-Retraction:-

The platelets are responsible for Retraction of blood clots over days.

③ Prevention of Blood Loss:-

① Platelets constrict the bleeding blood vessels.

②. Platelets due to their adhesive property seal the damage in blood-vessels & capillaries.

④ Repair of Ruptured Blood-Vessels:-

- Platelets secrete platelets derived growth factor (PDGF) responsible for repair of ruptured blood vessels.

- Functions of Blood -

① **Nutrient Function :-**

The Glucose, Amino-Acids, lipids, Vitamins derived from digested food are carried through-out the body by blood.

②. **Respiratory function :-**

Transport of Respiratory gases is done by the blood.

$$\text{lungs} \underset{CO_2}{\overset{O_2}{\rightleftarrows}} \text{Body organs}$$

③ **Excretory function :-**

The metabolic wastes are carried to the excretory organs by the blood.

④ **Transport of Hormones & Enzymes :-**

Hormones & enzymes are carried out through the body by the Blood.

⑤. **Water Balance :-**

The water content of blood is interchangeable c̄ interstitial fluid; thus regulating water Balance.

⑥ Body Temprature Regulation.

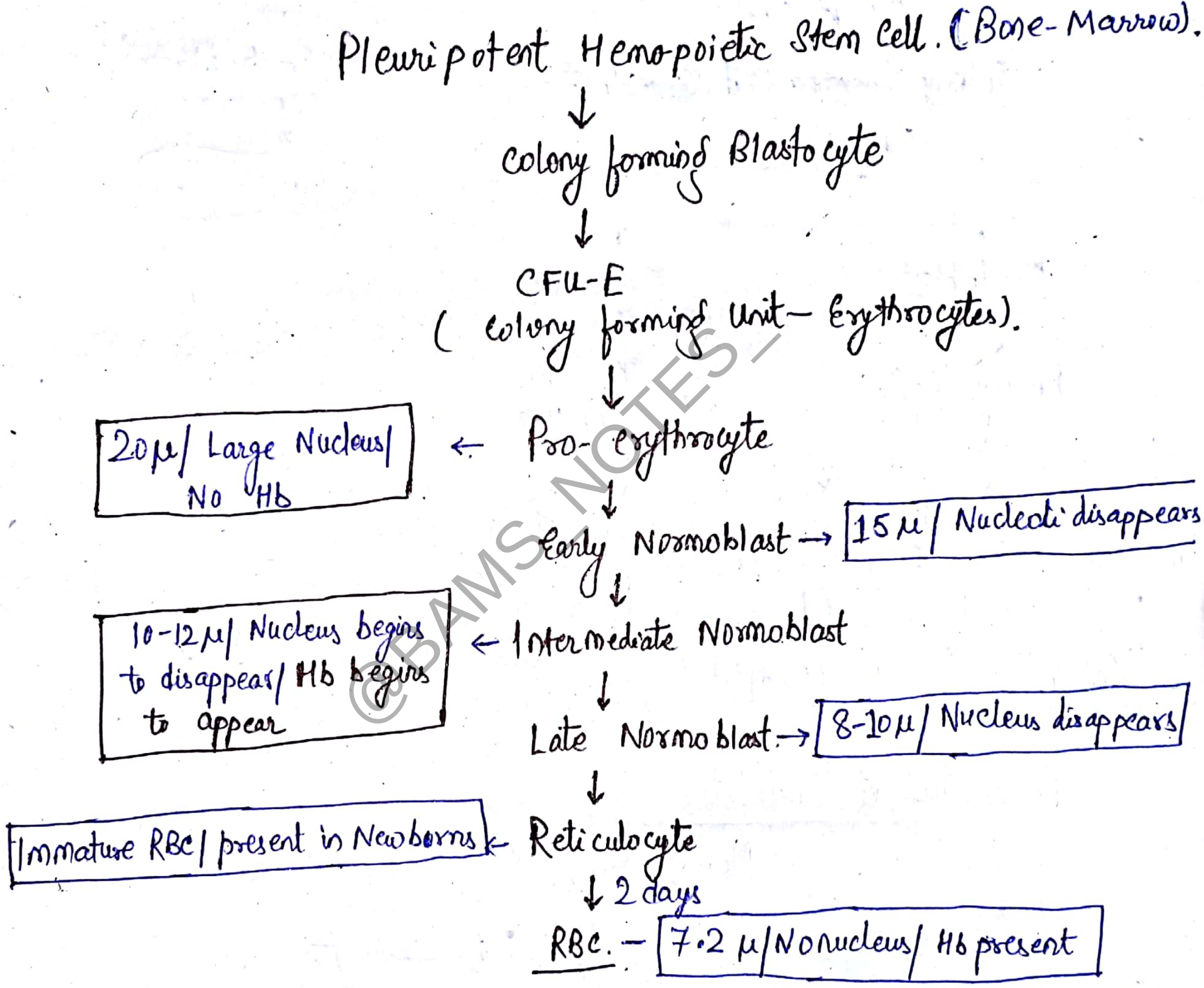
⑦ Storage function.

⑧ Defense- mechanism.

② Haemopoiesis.

- Formation of Components of Blood (Blood cells), development & maturation is called as Haemopoiesis.

① Formation of RBC (Erythrocytes).

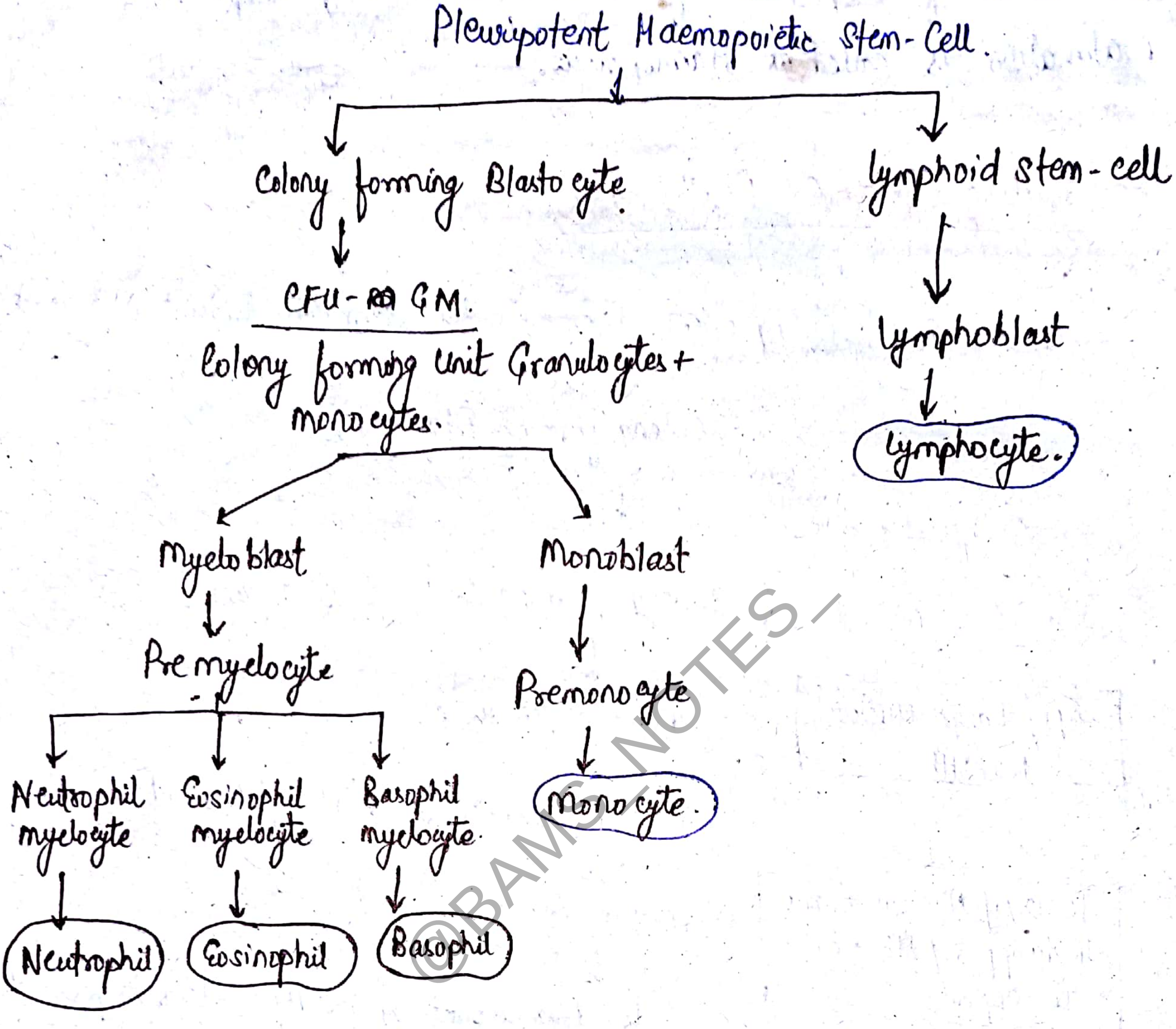


Pleuripotent Hemopoietic Stem Cell. (Bone-Marrow).
↓
Colony forming Blastocyte
↓
CFU-E
(colony forming unit – Erythrocytes).
↓
Pro-erythrocyte ← 20μ / Large Nucleus / No Hb
↓
Early Normoblast → 15μ / Nucleoli disappears
↓
Intermediate Normoblast ← 10-12μ / Nucleus begins to disappear / Hb begins to appear
↓
Late Normoblast → 8-10μ / Nucleus disappears
↓
Reticulocyte ← Immature RBC / present in Newborns
↓ 2 days
RBC. – 7.2 μ / No nucleus / Hb present

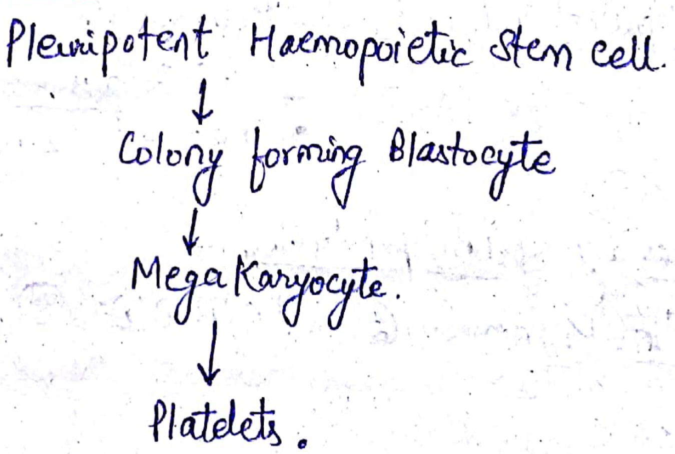
Factors Necessary for RBC production: –

① Erythropoietin. Kidney ② Vit C / B / D / E ③ Vit B_{12} ④ Folic Acid.

② Formation of WBC.


Pleuripotent Haemopoietic Stem-Cell.
Colony forming Blasto cyte
Lymphoid stem-cell
CFU-GM.
Colony forming Unit Granulocytes + monocytes.
Lymphoblast
Lymphocyte.
Myeloblast
Monoblast
Premyelocyte
Premonocyte
Neutrophil myelocyte
Eosinophil myelocyte
Basophil myelocyte
Monocyte.
Neutrophil
Eosinophil
Basophil

③ Formation of Platelets:-


Pleuripotent Haemopoietic Stem cell.
Colony forming Blastocyte
Mega Karyocyte.
Platelets.

• Composition & Functions of Bone Marrow.

- Bone Marrow; is a semi-solid tissue found in the spongy parts of the Bones.
- Bone marrow makes 4% of total body mass in adults, and it produces approx 500 billion blood cells/day.

Types of Bone Marrow:-

① **Red Bone Marrow:- / Myeloid Tissue.**

- Red blood cells, Platelets, and most WBCs are originated from Red Bone marrow.
- Red bone marrow mainly contains Hematopoietic stem cells.
- Red colour is due to Hb in erythroid cells.
- The level of Red bone marrow decreases c̄ age. (At Birth only Red Bone Marrow is present).

② **Yellow Bone Marrow:-**

- Contains high numbers of adipocytes (fat-cells).
- level of yellow bone marrow increases c̄ age.

Site of Red Bone Marrow:- Flat Bones, eg. Hip Bone, Clavicle, sternum, Skull, Ribs, Vertebrae & scapula.

Site of Yellow Bone Marrow:- Hollow, mid-portion of long Bones.

Functions:- formation of Blood cells.

Structure, Types & Functions of Haemoglobin.

- Haemoglobin (Hb) is the Iron-containing coloring matter of RBC. The main function of Hb is to carry O_2, CO_2; and also acts as Buffer.

Structure.

Hb is combined of 2 parts.

1). Iron part - Heme.
2). Protein part - Globin.

- Hb contains - 4 globular protein subunits (2α & 2β units). each subunit combines c̄ 1 molecule of Heme.

Types.

- Normal Hb is of 2 types.

① Adult Hb → HbA.
② Fetal Hb → HbF

- The HbA is composed of 2α and 2β chains in globin part, while HbF is composed of 2α and 2γ chains.

- After Birth HbF converts into HbA.

- HbF has more affinity for O_2 than HbA.

Normal value of Hb.

At Birth – 25 g/dL.
Adult male – 13.5 – 17.5 g/dL.
Adult female – 12.0 – 15.5 g/dL.

Functions :–

① Transport of O_2.

$O_2 + Hb \rightarrow$ Oxy Haemoglobin.

② Transport of CO_2 :–

$CO_2 + Hb \rightarrow$ Carboxy Haemoglobin.

Mechanism of Blood-clotting.

Definition:- Coagulation/clotting is defined as the process in which blood looses it's fluidity & becomes a jelly like mass, few minutes after it is collected in a container.

- The blood is a thin mesh(जाली) of fibrin Threads.

Blood-clotting Factors:-

Factor- I — Fibrinogen.
" II — Prothrombin.
III — Thromboplastin.
IV — Calcium.
V — Labile Factor.
VI — Presence not proved.
VII — Stable-factor.
VIII — Anti hemophilic factor.
IX — christmas factor.
X — Stuart-Prower factor.
XI — Plasma thromboplastin Antecedant.
XII — Hegman factor.
XIII — fibrin stabilising factor.

Mechanism.

Stages:- ① Formation of Prothrombin Activator.
② Conversion of Prothrombin into Thrombin.
③. Conversion of fibrinogen into fibrin.

- The blood clot formation begins with formation of Prothrombin Activator.

The formation of prothrombin Activator takes place by 2 ways.

①. Extrinsic pathway:- Formed by injured tissue,
② Intrinsic pathway:- formed by platelets.

Intrinsic Pathway:-

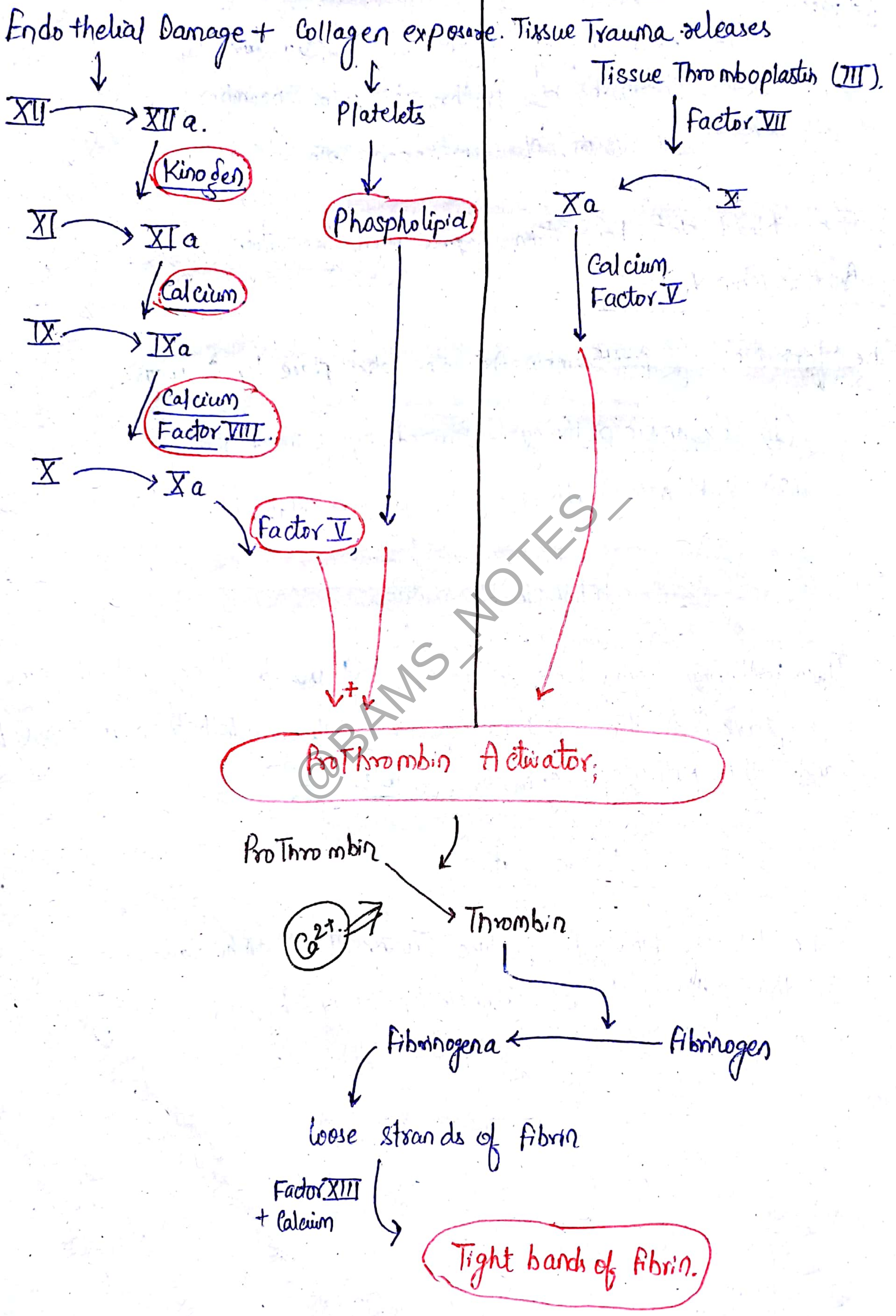
- This pathway, begins by rupture of blood vessels, the endothelium is ruptured & the collagen present below endothelium is exposed. and this pathway begins, by platelets.

Extrinsic pathway:-

- The tissues damaged, produce Factor III, Thromboplastin. In this pathway, the extrinsic pathway begins.

Intrinsic Pathway

Extrinsic Pathway


Endothelial Damage + Collagen exposure.
Tissue Trauma releases
Tissue Thromboplastin (III).
XII
XII a.
Kinogen
XI
XI a
Calcium
IX
IXa
Calcium
Factor VIII.
X
Xa
Factor V
Platelets
Phospholipid
Factor VII
Xa
X
Calcium
Factor V
+
ProThrombin Activator
ProThrombin
Ca^{2+}
Thrombin
Fibrinogena
Fibrinogen
Loose strands of fibrin
Factor XIII
+ Calcium
Tight bands of fibrin.

Stage-2. Conversion of Prothrombin Into Thrombin.

The Prothrombin Activator formed in stage-1 converts the Prothrombin into Thrombin in presence of Calcium.

Stage-3. Conversion of Fibrinogen into Fibrin.

The Thrombin converts the fibrinogen into Activated fibrinogen. Called as fibrin monomer.

→ These fibrin monomers form loose strands of fibrin, which later becomes tight in presence of Factor-XIII & Calcium.

Anti-coagulants

Anti-coagulants are substances, which prevent/postpone coagulation; are called anti-coagulants;

① **Heparin**:- naturally produced Anti-coagulant by mast-cells;
Mode of Action – Supressing the action of Thrombin.

Uses:– ①. To prevent Intravascular clotting during Surgery
②. Used during – dialysis/ Cardiac Surgery.

② **EDTA**:→ Ethylene-Diamine-Tetra-Acetic Acid (EDTA).
Acts by Removing Calcium from Blood.

③ **Calcium Oxalate** – Mixture of Ammonium oxalate : Pottasium oxalate
(3 : 2).

④ **Sodium-Citrate**:– Removes Ca^{2+} from Blood.

Physiological Basis of Blood-Groups.

Blood-groups are of 4 types.

① A.
② B.
③ AB.
④ O.

The physiological basis of blood-group; is presence of Antigens on surface of RBC; and antibody in the serum.

Group	Antigen	Antibody.
A	A	Anti B (β)
B	B	Anti A (α).
AB	A & B	No antibody.
O	No Antigen.	Anti A & Anti B.

Plasma-Proteins.

The plasma proteins are:-

① Serum Albumin.
② Serum Globulin.
③ Fibrinogen.- formed only during blood clotting.

Normal Values:-

- Serum Albumin:- 4.7 g/dL
- Serum Globulin:- 2.3 g/dL
- Fibrinogen:- 0.3 g/dL.

Normal A:G Ratio:- 2:1

Formation:- Reticulo endothelial cells of liver.

Functions.

①. Role in Blood-Coagulation:- Fibroinogen is essential for blood clotting.

② Body defense:- Globulins play an important role in defense mechanism by acting as antibodies.

③. Transport mechanism:- Transport of hormones, in blood.

④ Acid-Base Maintainence.

⑤. Role in Viscocity of Blood.

Anemia:-

Anemia is blood disorder characterised by.

① Reduced RBC

② Reduced Hb.

③ Reduced Packed-Cell-Volume. (% of RBC in blood).

Types:-

① **Morphological classification:-**

A). **Normocytic Normo-chromic Anemia:-** Size of RBC - **Normal**
% of Hb - Normal / Number of RBC → ↓

B). **Macrocytic Normochromic- Anemia:-**
Size - large / Hb - Normal / Number → ↓

c). **Macrocytic Hypochromic Anemia:-**
Size - large / Hb% - Less

d). **Microcytic Hypochromic Anemia:-**
Size - ↓ / Hb → ↓

② Etiological classification:-

① Hemorrhagic Anemia:- Due to acute/ chronic blood loss.

② Hemolytic Anemia:-
- ① Hepatic failure.
- ②. Renal disorder.
- ③. Burn.
- ④ Infection.
- ⑤ Poisoning.

③ Nutrition deficiency Anemia:-
- ① Iron deficiency
- ② Protein deficiency.
- ③. Vit B_{12} deficiency.
- ④ Folic - Acid deficiency.

④ Aplastic Anemia:-

- Bone Marrow disorder.

⑤. Anemia of chronic diseases: -
- ①. chronic Infections.
- ②. chronic Renal failure.

Clinical features:-

① Pale skin specially of – Conjunctiva; lips, Ear-lobes; palm & Nail Bed.

② . Tachycardia/ Increased Cardiac Output.

③ Increased Rate of Respiration.

④ Anorexia/ Nausea/ Vomitting.

⑤ Disturbed menstrual cycle.

⑥ Head ache, lack of concentration, drowsiness.

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② Introduction To Jaundice./Icterus

Jaundice/ Icterus is the yellow/ green pigmentation of skin & conjunctiva; due to high bilirubin levels.

C/F:-

① Yellow skin & Conjunctivae / Sclera.

② Dark Urine.

③ Restlessness/ lethargy/ Anorexia.

Types:-

① Hepato-cellular Jaundice – ↑ Unconjugated bilirubin.

② Hemolytic Jaundice – ↑ Breakdown of RBC.

③. Obstructive Jaundice. – Blockage of bile/ abnormal bile Retention in liver.

Normal level – below 1mg/dL.

◦ Bilirubin levels above 2-3mg/dL results in jaundice.

Unit. 21)

Immunity

- Classification of Immunity. – Innate; Acquired; Artificial.
- Different mechanisms involved in Immunity.
- Humoral (B-cell mediated). & T-cell mediated immunity;
- Hyper Sensitivity.

Definition :-

Immunity is defined as the capacity of the body to resist the pathogenic Agents.

Classification of Immunity.

Innate Immunity.
↓
Naturally Present in Body since Birth.

Acquired Immunity.
↓
Devlops against invading organisms.
↓
Destruction of invading organisms by Antigen presenting cells
↓
Release of Antigen.
↓
Presentation of Antigen.

To T-lymphocyte
↓
Cell mediated Immunity.
↓
Activation of T-Helper Cells
↓
Activation of cyto-Toxic T-cells
↓
Destruction by direct attack.

To B-lymphocyte.
↓
Humoral Immunity.
↓
Activation of B-cells
↓
Formation of Plasma-cells
↓
Production of Antibodies
↓
Destruction by Antibodies.

Innate Immunity-

Innate Immunity is the Inborn capacity of the body to resist the pathogen; it is also called -

- Ist line of defence.
- Non specific Immunity.

Mechanisms.

Structure	Mechanism.
G.I.T.	① Digestive enzymes & HCl of stomach. ② lysozyme present in Saliva.
Respiratory System.	① Neutrophils, lymphocytes, Macrophages & NK cells present in lungs.
Urogenital System.	① Acidity of Urine + Vaginal fluids.
Skin.	① Stratum-corneum. ② lysozyme in skin.
Phagocytic cells.	① Neutrophils. ② Monocytes ③ Macrophages.

Acquired Immunity:- Resistance devloped in body, against Specific foreign body eg Bacteria/ Virus/ Toxins/ Vaccine/ Transplanted tissues.

- Most powerful immune Mechanism of the Body.

Types of Acquired Immunity.

Cellular - Immunity. (Activation of different cells to destroy pathogens).
- Mainly carried out by T-lymphocytes.

Humoral Immunity (Activation of different Antibodies to destroy pathogens).
- Mainly B- lymphocytes.

① Cell-Mediated Immunity.-

- The cell mediated immunity is mainly carried out by T-lymphocytes.
- T- lymphocytes originate from stem cell & are transported to Thymus- gland for maturation.
- Later, when the thymus gland shrinks(adults) the T-lymphocytes are matured in lymph nodes, bone marrow, lymph vessels.

Types of T- Lymphocytes:-

① Helper T- cells.
② Killer/ Cytotoxic T-cells.
③ Supressor T-cells.
④ Memory T- cells.

Mechanism of Cellular Immunity.

Entry of micro-organisms in body

↓

Antigen presenting cells act on the micro-organism and present the antigen (specific protein) of the micro-organisms to the Helper T- cells.

↓

T- lymphocytes.

- Activates other T- cells.
- Activates Killer T cells
  - ↓ Attach to the surface of micro-organism.
  - ↓ Releases lyso somal enzymes.
  - ↓ Destroys the micro- organism.
- Activates B- Cells.
  - ↓ Stimulation of Humoral Immunity.
- Activates Natural Killer cells.
  - ↓ Cyto- Toxic Actions.

Supressor T- cells:- Controls the activity of Killer cells, and prevents destruction of own Body cells.

Memory - T-cells:- Remembers the micro-organism, and on 2nd attack of the same micro-organism, identifies and quickly activates other T- cells.

② Humoral Activity of(Immunity)

B- lymphocytes are mainly responsible for Humoral immunity; the B- lymphocytes are produced in bone marrow & liver and stored in- lymph Nodes, Spleen; GI Tract; Bone- marrow.

Types:- ① Plasma- Cells.
② . Memory- cells.

Plasma- Cells:- production of Antibodies.

- IgA. (Alpha) → present on mucosal surfaces.
- IgD. (Delta) → Activates B- lymphocytes.
- IgE.(Epsilon) → small amount in blood.
- IgG. (Gamma) → in blood & ECF/ Most abundant.
- IgM (mu) → Blood & lymph.

Memory- Cells:- ① Remembers the antigen of a micro- organism & on 2nd attack of same micro- organism, produces more antibodies on 2nd attack.

Mechanism of Humoral Activity.

Pathogen entry in Body

↓

Activation of Antigen Presenting cells.

↓

Presentation of Antigen

↓

Activated B- lymphocytes

↓

Antibody production.

- Agglutination
  ↓
  Antigens are held & sticked Together
- Precipitation
  ↓
  Soluble form of Antigens are converted into Insoluble form.
- Neutralisation
  ↓
  Antibodies cover the Antigens
- Lysis.
  ↓
  Antibodies rupture the cell wall of pathogen.

↓

Destruction of Pathogen.

Hyper- Sensitivity.

Hyper- Sensitivity / Allergy is defined as- abnormal immune Response to a chemical/ physical allergen.

Common allergic conditions are.

① Food Allergy
② Allergic- Rhinitis.
③ Bronchial Asthma
④ Utricaria.

Hyper Sensitive Reactions.

Anaphylactic Reactions.	– Very Quick Response. – Involved Antibody – IgE. – Reactions – ↓ B.P/ Broncho constriction/ Shock.
Cyto Toxic Reactions.	– Involved Antibody – IgG. – Examples – ① Rh- Incompatibility.
Antibody mediated Reactions.	– Involved Antibodies – IgG/ IgM. – Examples – ① Arthritis. ② Myocarditis.
Cell mediated Reactions.	– Slow type of Allergy. – T-lymphocytes are involved. Example – Rejection of transplanted organs.
Blocking/ Stimulatory Reactions.	Seen in Auto immune dis- orders.

Unit. 3. Muscle- Physiology.

- Comparison of physiology of skeletal muscles; Cardiac muscles; & Smooth muscles;
- Physiology of Muscle- Contraction.

---

①. Skeletal Muscles:-

- Skeletal muscles are situated in association with bones forming the skeletal muscles.
- Skeletal muscles form 40-50% of body mass.
- Skeletal muscles are voluntary & striated.
- Nerve Supply – Somatic Nerves.
- The skeletal muscles are connected to bone via Tendons.

②. Cardiac- Muscles:-

- Cardiac muscles form the musculature of Heart.
- These muscles are striated & involuntary.
- Cardiac muscles are supplied by Autonomic Nerve fibres.

③. Smooth Muscles:- also called as Visceral muscles.

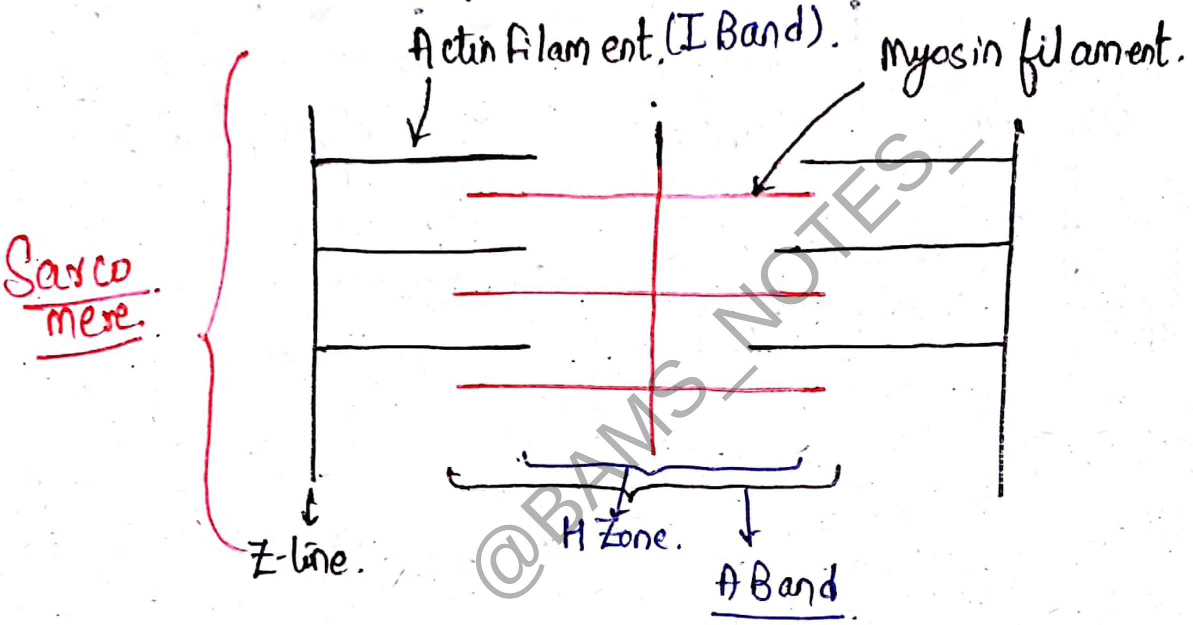
- These muscles are – non. striated & involuntary.
- Nerve Supply – Autonomic Nerve fibres.

Features.	Skeletal Muscles.	Cardiac Muscle.	Smooth Muscle.
Location.	In association c̄ Bones.	Heart.	Visceral Organs.
Shape.	Cylindrical & Unbranched.	Branched.	Spindle shape & unbranched.
Length.	1-4 cm.	80-100 μ	50-200μ.
Cross striations.	⊕	⊕	⊖
Myo fibrils.	⊕	⊕	⊖
Depolarisation	Upon stimulation	Spontaneous.	Spontaneous.
Fatigue.	Possible	Not possible	Not possible.
Tetanus.	Possible.	Not Possible.	Possible.
Action.	Voluntary	Involuntary	Involuntary.
Nerve Supply.	Somatic Nerves.	Autonomic Nerve	Autonomic Nerve.

Physiology of Muscle- Contraction.

- The muscle contraction occurs under control of motor-Neurons. (Somatic Nervous- System).
- The Nerve impulses reaches the Muscle fibre's sarcolemmal membrane) and creats the action potential.

Structure of a Myofibril:-


Actin filament.(I Band).
Myosin filament.
Sarco mere.
Z-line.
H Zone.
A Band

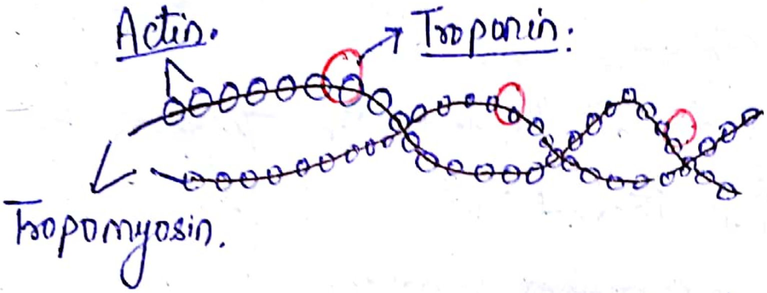
Each myofibril is composed of alternate dark & light Bands.

① light/I Band:- Made up of Actin filaments.

② A Band/Dark Band:- made up of Myosin filament.

Contraction:- of muscle fibres happens only when the Actin filaments are pulled by Myosin filaments towards the centre.

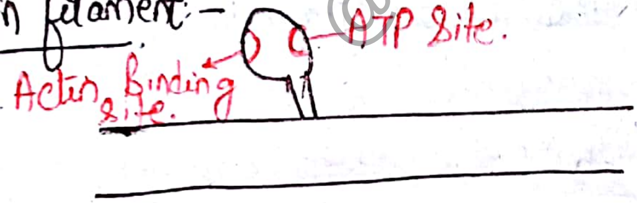
Actin Filament:-



The Actin filament is composed of actin molecules, attached in a helix form, also containing Tropomyosin & Troponin molecules.

- The Tropomyosin molecules prevent the conjugation of Actin & myosin.
- Troponin molecule attaches c̄ Calcium.

Myosin filament:-



T- Tubules:- are narrow tubules in the muscle fibrils formed by invagination of Sarcolemma.

Sarcoplasmic Reticulum:- longitudinal tubules on long Axis of muscle-fibrils

Muscle- Contraction.

The motor Nerve impulse creats action potential through the Sarcolemma → T-tubules → Sarcoplasmic Reticulum.

↓

The Sarcoplasmic Reticulum contains Calcium ions; and as the Ca^{2+} is Released.

↓

The Released Ca^{2+} binds c̄ the Troponin molecule present on Actin filament.

↓

As the Troponin binds c̄ the Calcium, the Tropomyosin molecules are pushed away from Actin of molecules.

↓

The Actin molecules attach c̄ the Actin Binding site of the myosin filament.

↓

The myosin now pulls Actin filament towards centre Resulting in Muscle-Contraction.

Unit. 4. Cardio-Vascular System.

- Functional Anatomy. ✓
- Cardiac-Cycle. ✓
- Regulation of Cardiac-out put & Venous-Return ✓
- Physiological basis of E.C.G. ✓
- Heart Rate & Regulation. ✓
- Arterial pulse. ✓
- Systemic Arterial B.P & it's Control. ✓

① Functional Anatomy:-

- Heart is a muscular organ that pumps blood through out the circulatory system.

Situation:- Heart is situated in b/w the two lungs in the mediastinum, in the left side of the body.

Chambers- 4.

① **Rt Atrium:-** Thin walled/ low Pressure chamber.

- Recieves deoxygenated blood from Superior & inferior Vena cava.
- Contains SA Node. (The Pace maker). & the AV Node.
- Communicates through Rt Ventricle by the Tricuspid Value.

② **Rt Ventricle:-** Thick walled/ High pressure chamber.

- Recieves deoxygenated blood from the Right Atrium.
- Gives Rise to Pulmonary Artery, which carries deoxygenated blood from the Rt Ventricle to the lungs.

③ **Left Atrium:-** Thin walled/ Low pressure chamber.

- Recieves Oxygenated blood from Lungs through Pulmonary Veins.
- Communicated through left Ventricle by Bicuspid/ mitral valve.

④ Left Ventricle:- Very Thick/ High pressure chamber.

- Left Ventricle pumps the blood through Systemic Aorta through out the body.

Layers of Heart wall.

① Pericardium. — Outer
② Myocardium. — Middle
③ Endocardium. — Inner.

Covering of Heart

Pericardium < Parietal layer (Outer).
Visceral layer (Inner)

Septa of the Heart:-

- Septa b/w Rt & left Atria:- Inter Atrial Septum.
- Septa b/w Rt & left Ventricle- Inter Ventricular Septum.

Valves of the Heart.

①. Left Atrio-Ventricular Valve – Mitral/Bicuspid Valve.

② Rt Atrio-Ventricular Valve – Tricuspid valve.

③ Aortic Valve → b/w left Ventricle & Aorta.

④ Pulmonary Valve → b/w Rt ventricle & Pulmonary Artery.

} Semiluna Valves.

Nodes in the Heart.

① SA Node.

② AV Node.

.Cardiac- Cycle.

① Definition:- "Cardiac Cycle is defined as the sequence of co-ordinated events which take place during each Heart Beat".

- Each Heart Beat's 2 major components.
  ①. Systole→ Contraction of cardiac muscle & pumping of blood from Heart through arteries.

  ②. Diastole:- Relaxation of Cardiac muscles & filling of the Blood.

Duration & Sub-divisions of a Cardiac cycle.

- When the Heart beats at Rate of 72/min; the duration of 1 cardiac cycle - 0.8 second.
  - Systole → 0.27 second.
  - Diastole → 0.53 second.

The Term Systole & Diastole in this context are meant for Ventricles.

- **Systole:-**
  - Isometric Contraction:- 0.05 sec
  - Ejection Period:- 0.22 sec

0.27 "

- **Diastole:-**
  - Protodiastole:- 0.04 sec
  - Isometric Relaxation:- 0.08 "
  - Rapid filling:- 0.11 sec.
  - Slow filling:- 0.19 "
  - last Rapid filling / Atrial Systole:- 0.11 sec

0.53 seconds

Atrial Systole:- (0.11 sec).

- The Bicuspid & Tricuspid valves open and 10% of blood is pushed from Atria into Ventricles.
- After Atrial systole the Atrial diastole also starts; and lasts about 0.7 sec.

② Isometric- Contraction:-

- Ist phase of Ventricular systole.
- The AV & Semilunar valves are closed; the Ventricles contract resulting in Increased pressure of Ventricles.
- As the AV- Valves close, the Ist Heart Sound (S_1) is produced.

③. Ejection Period:-

Due to High pressure in the ventricles the Semi-lunar valves open, and the blood is pushed to pulmonary Artery from Rt Ventricle & to aorta from left Ventricle.

This process is done into 2 steps.

①. Rapid ejection. - 0.13 sec.
②. Slow ejection - 0.09 sec.

④. Proto-diastole:- (0.04 sec).

- Ist stage of Ventricular diastole.

- As the blood passes away from ventricles, the pressure in the ventricles are decreased, Resulting in closure of the Semi-lunar valves.
- Closure of Semi-lunar valves produces 2nd Heart Sound (S_2).

⑤ Iso-metric Relaxation:-

- Now, the Ventricular pressure decreases, due to relaxation of the Ventricles.
- Semilunar & AV-Values are closed during this period.

⑥. Rapid-filling Phase:-

- Due to decreased pressure in the Ventricles, the Atrioventricular values open resulting in Rapid filling of the Ventricles.
  - About 70% of blood filling in Ventricles takes place.

⑦ Slow filling phase:-

After the sudden Rush of Ventricular filling; the slow filling is now taking place.

- 20% of filling occurs in this phase.

Regulation of Cardiac-output & Venous Return.

① **Cardiac-Output:-**

Cardiac-output is the amount of Blood pumped from Ventricles.

Cardiac Output = Stroke Volume x Heart Rate.

(blood-pumped by Heart/stroke)

= 80 ml x 72

$\boxed{\simeq 5 \text{ litres/ Ventricle/ minute}}$.

Regulation of Cardiac-output.

The Cardiac output is Regulated By:-

1. Venous Return.
2. Force of Contraction.
3. Heart Rate.
4. Peripheral Resistance.

① **Venous-Return:-** Venous-Return is the amount of blood; which is returned to the heart from different parts of the body.

$\boxed{\text{Venous Return} \propto \text{Cardiac-Output}}$.

②. Force of Contraction:-

- The Cardiac output is directly proportional to the Force of Contraction of Heart.

$$\boxed{\text{Cardiac output} \propto \text{Force of Contraction}}$$

③ Heart Rate:-

$$\boxed{\text{Heart Rate} \propto \text{Cardiac Output}}$$

④ Peripheral Resistance:-

- Peripheral Resistance is offered by Arterioles.

$$\boxed{\text{Cardiac Output} \propto \frac{1}{\text{Peripheral Resistance}}}$$

Venous Return :-

Venous Return is the Amount of blood, which is returned to the Heart from different parts of the body.

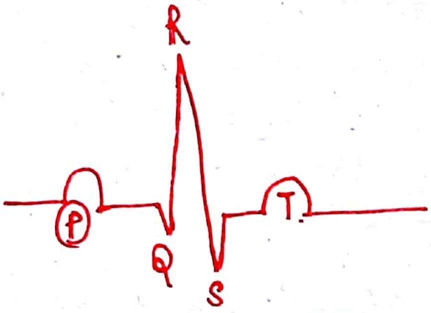
Factors affecting the Venous-Return.

① Respiration.
② Muscle - Activity.
③ Gravity.
④ Sympathetic Tone.

Physiological Basis of E.C.G.

- **Electro-Cardio-Graphy**:- is the technique by which the electrical activities of the Heart are studied.
- **Einthoven Willem** is father of E.C.G.

Components of an E.C.G.



Waves of E.C.G:-
① P wave
②. QRS complex.
③. T-wave.

Intervals:-
① PR Interval.
②. QT Interval.
③ R-R Interval.

Segments:-
① ST- Segment.

① P-wave:-

- Positive wave.
- Ist wave in E.C.G.

Duration - 0.1 second.
Amplitude:- 0.1- 0.12 mV.

- P wave is produced due to depolarisation (Contraction) of Atrial musculature.

② QRS- Complex:-

Duration- 0.08- 0.10 sec/

QRS complex represents depolarisation of Ventricular musculature.

Q Wave:- Negative wave/ Represents depolarisation of Inter Ventricular Septum.

R wave:- Positive wave/ Represents depolarisation of apical part of ventricular muscle.

S wave:- Negative wave/ Represents depolarisation of basal part of Ventricles.

③ T-wave:-

Represents the Repolarisation of Ventricles
Positive wave/.

Time- 0.2 sec
Amplitude- 0.3 mV.

• Heart Rate & it's Regulation.

Normal Heart Rate:— 72/min

Range- (60-100/min).

Tachycardia:- Increase in H.R more than 100/min. is called Tachycardia.

Bradycardia:- Decrease in H.R below 60/min. is termed as Bradycardia.

Regulation of Heart-Rate.

- Heart Rate is Regulated by Nervous-System. The mechanisms involved in control of Heart-Rate are:-

1). Vasomotor Centre.

2). Motor Nerve fibres to the Heart.

3). Sensory Nerve fibres from the Heart.

① Vasomotor - Area / Cardiac- Centre.

(Medulla- oblongata)

Cardio-Accelerator Centre.

↓

Send impulses to Heart through Sympathetic Nerves.

↓

~~Decreased H.~~

Increased H.R.

Cardio- Inhibitory Centre.

↓

Send impulses to Heart through Vagus Nerve.

↓

Decreased H.R.

② Motor- Nerve fibres.

Motor Nerves.

Para-Sympathetic.

↓

Vagus Nerve.

↓

↓ H.R.

Sympathetic.

↓

Spinal Nerves $T_1 - T_4$.

↓

↑ H.R.

③. Sensory Nerve fibres:-

Sensory Nerve fibres from Heart.

↓

Inferior Cervical Sympathetic Nerve

↓

Spinal Cord

↓

Brain.

Arterial Pulse.

Arterial pulse is defined as the pressure changes; transmitted in the form of waves, through arterial wall and blood column from Heart to periphery.

Pulse - points.

① Temporal Pulse:– Over the Temple' in front of the ear/ Temporal Artery.

② Facial Pulse:– On Angle of Jaw/ Facial Artery.

③ Carotid Pulse– In the Neck/ Common- Carotid Artery.

④ Axillary Pulse– In Axilla/ Axillary Artery.

⑤ Radial pulse– On the Thumbside of Wrist/ Radial Artery.

⑥. Femoral pulse– In the Groin/ Femoral Artery.

⑦. Dorsalis- pedis Pulse– Over Dorsum of Foot/ Dorsalis pedis Artery.

⑧. Tibialis Pulse– Over Back of Ankle / Post. Tibial Artery.

→ Systolic Arterial B.P & it's Control. ←

- Arterial Blood pressure is defined as the lateral pressure exerted by contained colum of blood on the wall of arteries.

Systolic B.P:- Maximum pressure exerted in the arteries during Systole of the Heart.

Normal Range- 110-140 mmHg.

Diastolic B.P:- Minimum pressure in the arteries during diastole of the Heart.

Normal Range- 60-80 mmHg.

Pulse Pressure:-

Diastolic B.P - Systolic B.P = Pulse pressure.

Normal value= 40 mmHg.

Mean Arterial B.P:-

Mean B.P = Diastolic pressure + $\frac{1}{3}$ of Pulse-pressure.

= 80 + 13 = 93 mmHg.

Control of B.P.

- Nervous System.
- Renal mechanism
- Hormonal Mechanism
- Local Mechanism.

① Nervous System–

Vasomotor Area
(Medulla oblongata)

- Vasoconstricter Area.
  ⇓
  ↑ B.P.
- Vasodilator Area.
  ⇓
  ↓ B.P.

B). Sympathetic Fibres – ↑ B.P
Para Sympathetic fibres – ↓ B.P.

② Renal mechanism:–

Kidney Regulates water Balance in Body

- Water Retention
  ↓
  ↑ B.P
- Water diuresis
  ↓
  ↓ B.P.

③ Hormonal Mechanism:-

① Hormones ↑ B.P.

A). Adrenaline.
B). Nor-Adrenaline.
c). Thyroxine.
D). Vasopressin.
E). AngioTensin.

① Hormones ↓ B.P.

A). Prostaglandins.
B). Histamine.
c). Acetyl-choline.

④ Local Mechanism:-

A). Local Vaso-Constrictors:-

- Substances called endothelins,
- Released by Stretching of Blood-vessels.
- Vaso-constrictor
- ↑ B.P.

B). Local Vaso dilators:-

1) CO_2.
2). HydrogenIons
3). Nitric-Oxide (NO).

Unit. 5).

Adipose Tissues; VLDL; LDL; HDL; Triglycerides.

Adipose Tissues:- Also called Body fat; is a loose connective tissue composed of adipocytes;

Locations:-

1. Sub-cutaneous fat.
2. Visceral fat.
3. Yellow Bone- Marrow.
4. Breast- Tissue.

Functions:-

1. Acts as Insulating layer i.e. Reduces Heat loss through skin.
2. Protection of Organs.
3. Energy Storage.

✱.

② VLDL:- (Very low- Density lipo-Protein).

- VLDL is type of lipo-protein made by liver. from Triglycerides; cholestrol; lipo-proteins.

Functions:- Transports Triglycerides, cholestrol, phospholipids in the blood.

③. tip Low-Density lipo-protein(LDL).

→ Carries all fat molecules around the body in the extracellular water.

Unit. 6.

Functions of Skin; Sweat Glands & Sebaceous Gland.

① Functions of Skin:-

A). Protective function:-

1) Skin covers the organs of body & protects the organs from having direct contact c̄ external environment.

2). Skin produces lysozyme to destroy the Bacteria.

3). Skin provides protection from Mechanical blows.

4). Skin protects body from U.V. rays of Sun light.

B). Sensory function:-

Skin provides Senses of
- Touch, Pain, Pressure, Temprature.

C). Storage:- Skin stores, fat, water, chloride & Sugar.

D). Synthesis of Vit D_3:- Vit D_3 is Synthesized in Skin in presence of Sun light.

E). Regulation of Body Temprature:- By Sweating.

8) **Excretion**:- Skin can excrete Urea, Salts, fatty substance.

9). Secretory function:- Skin secrete sweat/ sebum.

- **Functions of Sebum**:-

① Anti- Bacterial

②. Anti- fungal.

③ Keeps skin smooth & oily.

④ Prevents heat loss from body.

Unit 7.

Physiology of Male & female Reproductive Systems;

Description of ovulation, Spermatogenesis; Oogenesis; Menstrual Cycle.

Male Reproductive System.

Male Reproductive organs include the primary sex organs; and accessory sex organs.

◦ Primary Sex Organs.

① Testis:-

- Testis is the primary male sex organ in males.
- Testis are 2 in Number.
- In humans testis are situated in scrotum.
- Size- 5×3 cms.
- Weight- 15- 19 grams.
- Testis contains 900 coiled tubules called Seminiferous- tubules; which produce sperms.

Accessory Sex- Organs.

① Seminal Vesicles.

② Prostate Gland.

③ Urethera.

④ Penis.

① Seminal Vesicles:-

- Seminal vesicles are a pair of glands situated on either side of prostate gland.
- Secretions of seminal vesicles (Seminal fluid); are emptied into vas-deferens.
- The seminal fluid contains—
  - Proteins.
  - Enzymes.
  - Fructose.
  - Mucus.
  - Vit. C.
  - Prostaglandins.
- Seminal fluid provides nutrition to the spermatozoa; causes stickyness & jelly like form of semen after ejaculation.

② Prostate Gland:-

Prostate glant is a walnut shaped gland present b/w bladder & the penis.

- The prostrate secretes 'prostatic fluid' which contains glucose, proteolytic enzymes, and zinc.
- Prostrate gland opens into internal urethera through utriculus prostaticus.

③ Urethera:-

Urethera is the common passage for sperms & Urine.

① Internal urethera is the continuation of ejaculatory duct;
② External urethera is the continuation of internal urethera passing through penis.

④ Penis:-

Penis is the male genital organ; Urethera passes through penis & opens to exterior.

Penis is formed by 3 erectile tissues.

2 – Corpora cavernosa.
1 – Corpus spongiosum.

Sperm Pathway.

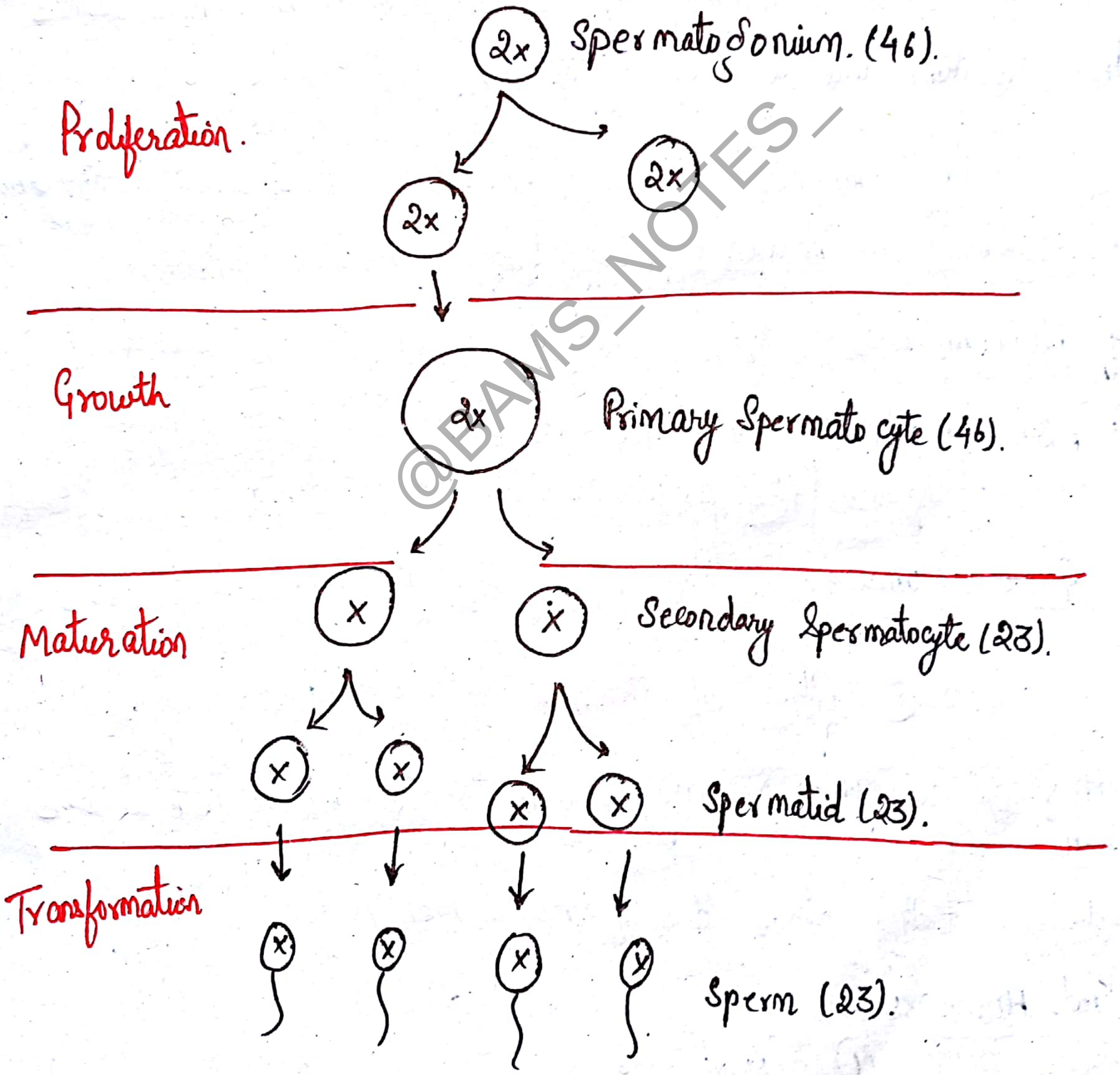
Seminiferous Tubules
↓
Rete-Testis.
↓
Vas-efferens
↓
Epididymis
↓
Vas-deferens
↓
Ampulla
↓
Ejaculatory duct
↓
Urethera.

Spermatogenesis.

- Spermatogenesis is the process, by which the male gametes called spermatozoa (sperms) are formed in the Testis.

- Complete formation of a sperm from the spermatogonium takes 74 days.

Spermatogenesis diagramatic Representation.


2x
Spermatogonium. (46).
Proliferation.
2x
2x
Growth
2x
Primary Spermatocyte (46).
Maturation
x
x
Secondary Spermatocyte (23).
x
x
x
x
Spermatid (23).
Transformation
x
x
x
y
Sperm (23).

Stages of Spermatogenesis.

① Stage of Proliferation.
② Stage of Growth.
③ Stage of Maturation.
④ Stage of Transformation.

① Stage of Proliferation.

- In this stage the spermatogonium having 46 chromosomes divide by mitosis resulting into 2 spermatogonium.
- The spermatogonium migrate from basement membrane of seminiferous tubules towards the lumen of seminiferous tubules.

Role of Hormones:-

① FSH → • Initiates spermatogenesis.
• Induces the proliferation of spermatogonia.

②. Growth Hormone → essential for general metabolic processes.

② Stage of Growth.

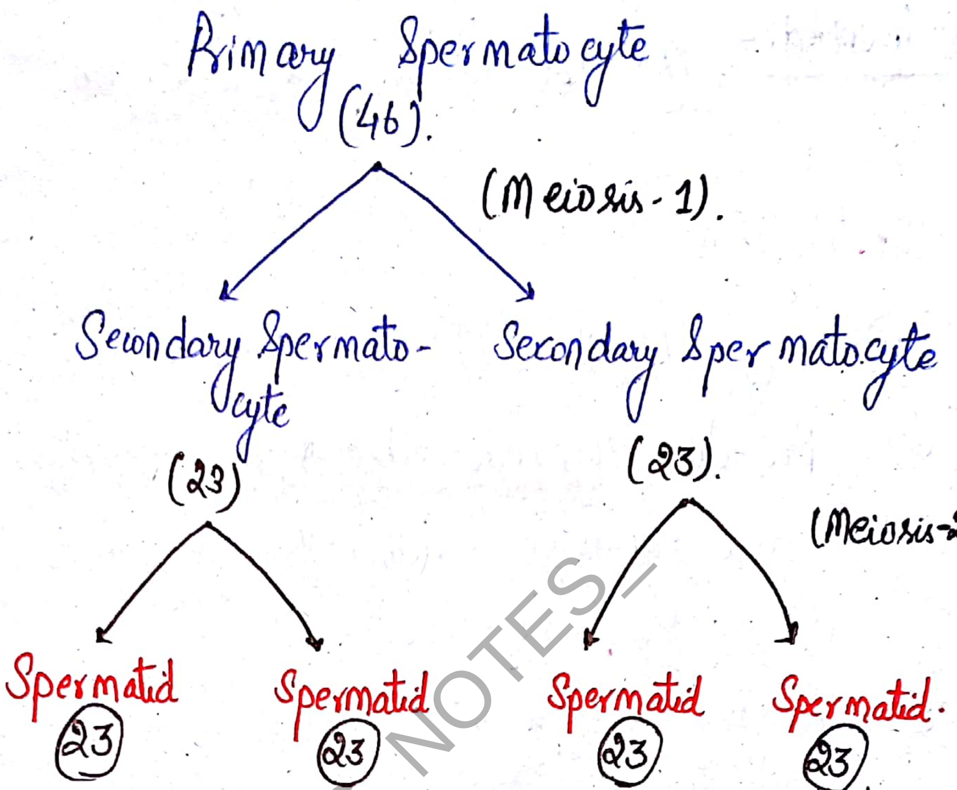
- In this stage the primary spermatocyte grows into a large cell.
- No divisions takes place during this stage.

Involved Hormones:-

①. Testosterone.
②. Growth Hormone.

③ Stage of Maturation.

During this stage the primary spermatocyte undergoes meiotic division.


Primary Spermatocyte
(46).
(Meiosis-1).
Secondary Spermato-cyte
(23)
Secondary Spermatocyte
(23).
(Meiosis-2).
Spermatid
23
Spermatid
23
Spermatid
23
Spermatid.
23

Involved Hormones :- ① Testosterone ② Growth Hormone.

④. Stage of Transformation.

The spermatids are now transformed into matured sperms. This process is called Spermeogenesis.

Changes during Spermiogenesis :-

① Nuclear material becomes dense.

②. formation of Acrosome/mitochondrial spiral filament/ Tail.

③ Removal of extra cytoplasm.

Spermination:-

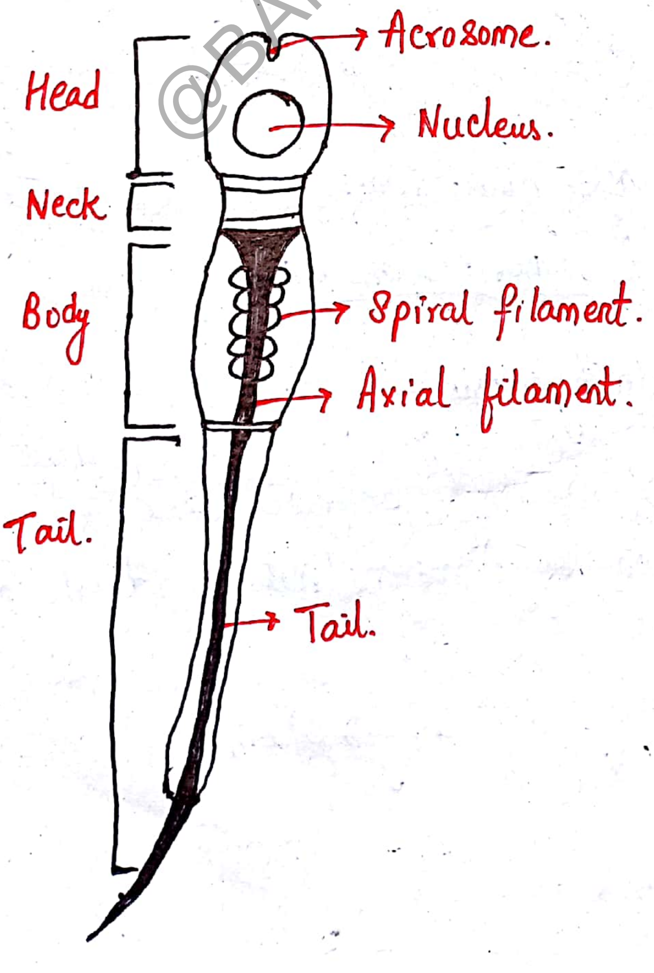
Spermination is the process by which the mature sperms are released from Sertoli cells into lumen of Seminiferous Tubules.

Hormones Involved:- ① Testosterone ② Estrogen.

Role of Sertoli cells:-

① Support & Nourish germ-cells.
② Provides Hormonal substances needed for spermatogenesis.
③. Secrete Androgen binding Protein which is essential for action of Testosterone.
④ Releases sperms into lumen of seminiferous tubules.

Sperm.


Acrosome.
Nucleus.
Head
Neck
Body
Spiral filament.
Axial filament.
Tail.
Tail.

Head:-

- Head of sperm is oval in shape;
- Length- 3-5μ.
- Width- 3μ.

- Head contains- ①. Nucleus
  ②. Thin cytoplasm
  ③. Acrosome.
  (Acrosome contains hyaluronidase & proteolytic enzymes which pierce the ovum).

Body :-

①. Cylindrical in shape.
②. length- 5-9μ.

Consists of- ①. Axial filament.
②. Spiral filament made of mitochondria.

Tail:-

is made up of 2 parts.
A). chief part of Tail.
B). End piece of Tail.

– Female Reproductive System –

Female Reproductive System is composed of –

① Primary Sex-Organs –
→ A pair of ovaries.

② Accessory Sex-Organs :–

① System of Genital ducts –
- Fallopian Tubes.
- Uterus.
- Cervix.
- Vagina.

② External Genitalia :–
① labia majora.
②. labia minora.
③. clitoris.

. Description of Ovulation.

- Introduction :-

  - Ovulation is the process by which the graffian follicle in the ovary ruptures, and the ovum is released into the abdominal cavity;

    The ovum released into the abdominal cavity enters the fallopian tube through the fimbriated end of the tube.

- Normally, ovulation occurs on 14th day of menstrual cycle in a normal cycle of 28 days.

- LH (Lutenizing Hormone) is Responsible for ovulation.

Movement of Graffian follicle to the periphery of Ovary

LH.
Progesterone →

↓

Formation of New Blood vessels in ovary by actions of LH & Progesterone.

↓

These new blood vessels protude into the wall of Graffian follicle

↓

Increased Blood flow to the Graffian follicle.

↓

Prostaglandins from Granulosa cells of follicle

↓

Leakage of plasma into the Graffian follicle.

↓

Size of Graffian follicle ↑↑.

↓

Now, the Graffian follicle protudes against the capsule of ovary; This protusion is called Stigma.

Progesterone →

↓

Progesterone activates the proteolytic enzymes present in theca-interna of the Graffian follicle

↓

Progesterone also causes degeneration of the stigma.

↓

Stigma & Graffian follicle rupture.

↓

Release of Graffian follicle's fluid

↓

Release of Ovum in the Abdominal cavity.

- Oogenesis -

Oogenesis is the process of maturation of female gamete i.e the ovum.

Begining:- Oogenesis starts by development of primary oocytes from the oogonia.

The transformation of oogonia into primary oocytes is completed by 20 weeks; of fetal life.

The number of primary oocytes is 6-7 million by 20 weeks of fetal life; which reaches upto 2 million by Birth.

- All The oogonium does not survive until puberty and the number of primary oocytes by puberty is 60,000-80,000.

Puberty:- By puberty, the primary oocytes are arrested in Stage- Prophase I of meiosis.

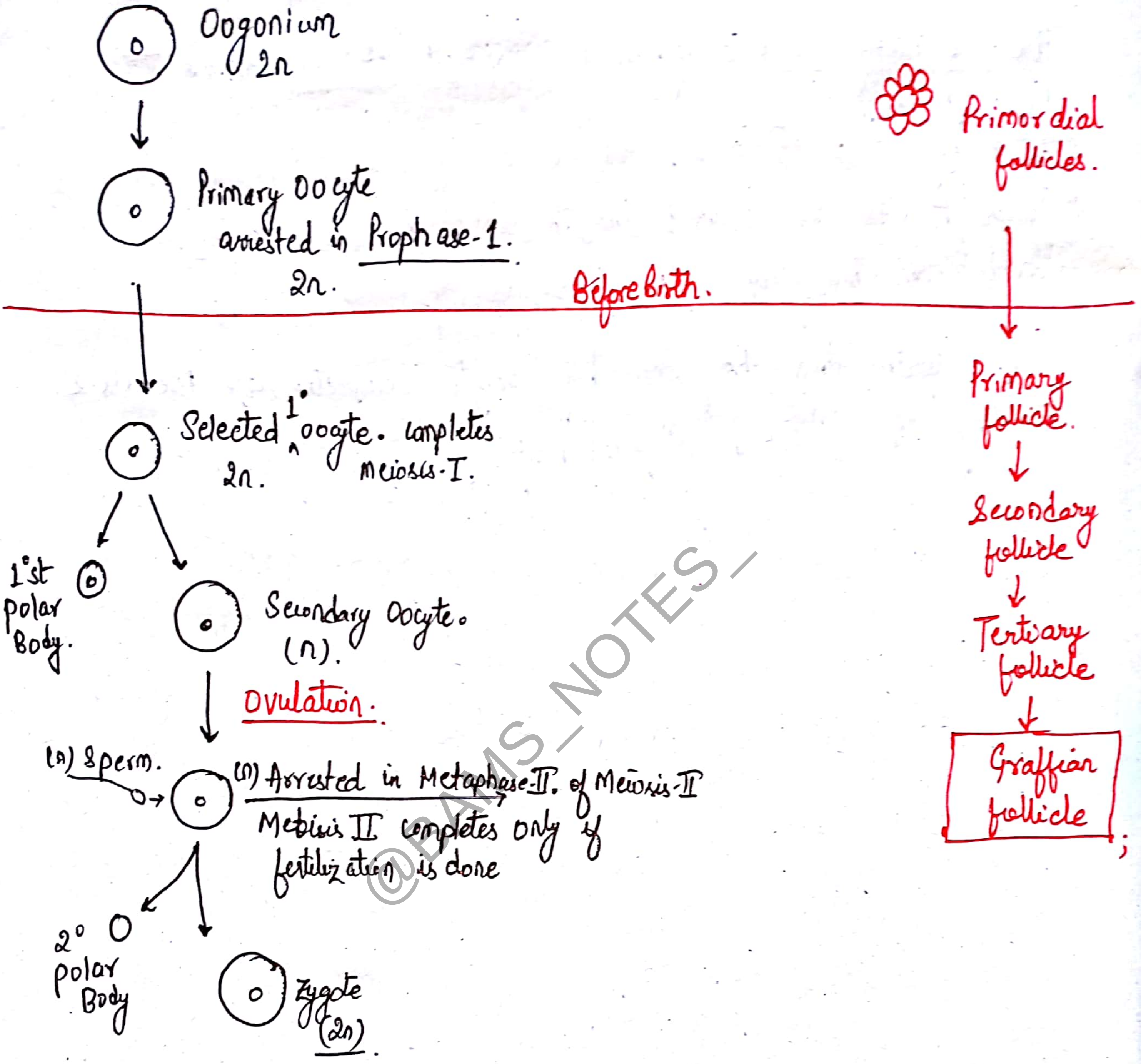
Further development:- The selected primary oocyte completes it's meiosis I, 36-48 hours prior to ovulation, to form Secondary oocyte & a small polar Body.

The Secondary oocyte is Released from Graffian follicle during ovulation.

- The Secondary Oocyte again is arrested at Metaphase-II. Stage of Meiosis-2.
- This Arrest is caused due to abscence of Centriole; which can be only supplied by sperm.
- After fertilisation the Secondary oocyte completes it's Meiosis-2. resulting in Ovum & 2° polar Body.

OOgenesis.

follicle devlopment.


Oogonium
2n
Primary oocyte
arrested in Prophase-1.
2n.
Before Birth.
Selected 1° oocyte completes
2n.
Meiosis-I.
1'st polar Body.
Secondary Oocyte.
(n).
Ovulation.
(n) Sperm.
(n) Arrested in Metaphase-II. of Meiosis-II
Meiosis II completes only if
fertilization is done
2° polar Body
Zygote
(2n)
Primordial follicles.
Primary follicle.
Secondary follicle
Tertiary follicle
Graffian follicle

- Menstrual Cycle -

- The cyclic events that take place in a Rhythmic fashion during the Reproductive period of a womans life is called Menstrual cycle.

Menarche – The begining of menstrual cycle is called menarche. The average age of menarche is 12-15 years.

Menopause – The permanent cessation (stoppage) of menstrual cycle at age of 45-50 years is called menopause.

Duration of Menstrual Cycle – 28 days (20-40 days).

Changes during Menstrual Cycle.

① Ovarian changes.
② Uterine changes.
③ Vaginal changes.
④ cervix changes.

Ovarian changes.

The ovarian changes occur in two phases.

① Follicular-phase.
② Luteal - phase.

① Follicular-phase.

- Follicular phase begins on day 5 of menstrual cycle and continues till Day-14, until ovulation occurs.
- In the follicular stage, the ovarian follicles mature and becomes ready for ovulation.

The follicular devlopment stages are:-

① Primordial follicle.
② Primary follicle.
③. Vesicular follicle.
④. Graffian follicle.

① Primordial follicle:-

- At the Time of puberty; the ovaries contain 4,00,000 primordial follicles.
  - Primordial follicle size - 15-20μ
  - Ovum size - 10 μ.
- The Primordial follicle has an ovum surrounded by Granulosa cells.

Granulosa cells secrete.

→. Oocyte maturation Inhibiting factor.

→. provide nutrition to ovum.

At the onset of puberty; under the influence of FSH & LH; the primordial follicles starts growing through.

②. Primary follicle.

- The primordial follicles undergoes following changes-
  - Proliferation of granulosa cells.
  - Increase in size of follicle (30-40μ).
  - Increase in size of ovum (20μ).
  - Formation of connective tissue around the ~~tissu~~ follicle.

③. Vesicular follicle.

- Under the influence of FSH; about 6-12 primary follicles starts growing & devlop into vesicular follicle.

①. formation of cavity in the follicle called Antrum.

② Antrum is filled c̄ fluid.

③ Size of follicle increases.

④. Ovum is pushed to one side; and covered by granulosa-cells.

⑤ Ovum increases in size (100-150 μ).

⑥ Nucleus becomes large & vesicular.

⑦. The follicle devlops 2 layers.
 - Theca interna.
 - Theca externa.

④ Graffian-follicle.

① follicle size increases to 10-12 mm.

② follicle pushes the surface of ovary; the protusion is called stigma.

③. Ovum attains maximum size.

④. On the 14th day, under effect of LH; the Graffian follicle becomes ready for ovulation.

Luteal Phase.

The luteal phase extends from Day 15 - 28 of menstrual cycle. During this phase corpus-lut eum is developed.

- The Ruptured Graffian follicle changes into corpus luteum. It is also called yellow body.

Formation of Corpus-luteum.

Rupture of Graffian follicle
&
Release of ovum
↓
follicle becomes filled c̄ blood.
(Corpus-Hemorrhagicum).
↓
Blood clot formation.
↓
The follicular cavity closes
↓
Blood clot is Replaced by Serous fluid.
↓
Corpus-luteum.
(Size- 15mm)

Functions of Corpus-luteum.

① **Hormone Secretion:-**

- large quantity of progesterone.
- Small quantity of estrogen.

② **Maintainence of Pregnancy:-**

- Corpus luteum is active until 3 months of pregnancy & then placenta takes over it's functions.

Fate of Corpus-luteum.

① **If Pregnancy don't occurs -**

Corpus luteum functions for
1 week
↓
Corpus luteum menstrualis
↓
Corpus albicans
↓
Degeneration.

② If Pregnancy occurs:-

Corpus luteum increases in size (20-30 mm)

↓

Corpus luteum of pregnancy.

↓

functions for 3-4 months

↓

Degenerates; after formation of placenta.

② Uterine changes.

The uterine changes during a menstrual cycle occurs into 3 phases-

① Menstrual phase.
② Proliferative phase.
③ Secretory phase.

① Menstrual Phase.

- Day - 1 — Day 5.

- On the 26th - 27th day of ~~men~~ previous menstrual cycle, the sudden decrease of progesterone & estrogen. begins following changes-

① Reduction in thickness of endometrium upto 65% of original Thickness.

② Sudden decrease of progesterone, estrogen & secretions of prostaglandins from the endometrium causes Vasoconstriction.

③. The Vasoconstriction causes.
  ① Rupture of endometrial Blood vessels.
  ② Necrosis of endometrium.

④. The Necrotic endometrium & blood in endometrial cavity initiate uterine contractions.

⑤. Uterine contractions expel out the uterine endometrial tissues c̄ blood.

- An enzyme fibrinolysin prevents the blood-clotting in the endometrial cavity.

Menstrual Blood.

Volume:- 70-80 ml. (Half Blood + Half Serous fluid).

Contents - ① Blood.
② Cervical mucus.
③. Vaginal secretions.
④ Endometrial Tissues. ⑤ Sloughs of unfertilized egg.

Colour:- Reddish-Brown.

② Proliferative Phase.

- Day 5 - Day 14. Main Hormone- Estrogen.

- At the end of menstrual phase, only a thin layer of endometrium (1mm) remains.

Changes during Proliferative Phase:-

① Endometrial cells proliferate rapidally.

②. Endometrial surface, uterine glands, Blood vessels appear & grow rapidally.

③. Endometrium becomes 3-4mm thick at the end of proliferative phase.

③ Secretory Phase.

Day - 15 - 28 ;

Main Hormone:- ① Progesterone (Corpus-luteum)
② Estrogen (Corpus-luteum).

Changes -

① Under influence of Progesterone, the endometrial glands becomes more Tortuous.

② Thickness of endometrium increases upto 5-6 mm.

③. Deposition of glycogen & lipids in the uterine cells.

④ Appearence of new blood vessels in endometrium.

⑤ Increased blood supply to endometrium.

- If fertilization occurs, during this phase the zygote is implanted in the endometrium.
- If fertilization don't occurs, the level of progesterone & estrogen decreases & menstruation begins.

Role of Hormones in Menstrual Cycle.

GnRH.	Hypothalamus.	Pulsatile Secretion of GnRH; stimulates secretion of FSH & LH.
FSH (Follicle Stimulating Hormone)	Ant. Pituitary	○ Promotes follicular devlopment. ○ maintains Activity of Corpus-luteum. ○
LH (Leutinising Hormone).	Ant. Pituitary	○ Induces devlopment of Corpus luteum. ○ Stimulates Corpus-luteum functions. ○ LH Surge is Necessary for ovulation. ○ Stimulates Graffian-follicle.
Estrogen.	Ovary	○ Growth of follicles. ○ Growth of endometrium.
Progesterone	Ovary	○ Strengthens the endometrium.

Unit 8. Physiology of Excretion.

- functional Anatomy of Urinary Tract. ✓
- functions of Kidney. ✓
- Mechanism of Urine formation. ✓
- Control of Micturition. ✓
- formation of faeces. ✓
- Mechanism of defecation. ✓

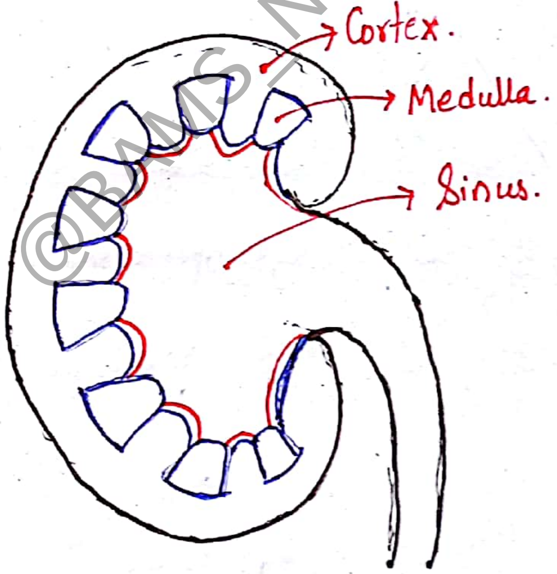
① functional Anatomy of Urinary Tract.

- The Urinary Tract is made up of Kidneys, Ureter, Bladder, & the Urethera.

① Kidney :-

- Kidneys are a pair of bean shaped organs located below the ribs, near the middle of the back.
- The components of Kidney are arranged into 3 layers.

① Outer- Cortex.
② Inner- medulla.
③. Renal- Sinus.



② Ureters:-

- The ureters are fibro-muscular Tubes that carry the urine from Renal pelvis to the Urinary Bladder.
- The Area, where the ureters enter the bladder is called the Trigone.

③ Bladder:-

Urinary bladder is a hollow, muscular organ that stores urine. It is located behind the pubic-Bone, and is held by ligaments.

④. Urethera:-

Urethera is the Tube, that passes urine from the bladder out of body.

2). Functions of Kidney.

① Role in Homeostasis:-

The Kidney maintains homeostasis by;

a). Excretion of Waste Products:-

- Kidneys excrete:-
  a). Urea.
  b). Uric-Acid.
  c). Creatinine.
  d). Bilirubin.
  e). Toxins.
  f). Drugs.
  g). Heavy-metals.

b). Water Balance:-

- Kidneys conserves water in case of water decrease
  &
- excrete excess water in case of water increase.

c). Electrolyte Balance:-

- Kidneys maintain sodium balance mainly.

d). Acid- Base Balance:-

Kidneys excrete metabolic acidic products.

② Haemopoietic function:-

- Kidneys secrete erythropoietin necessary for erythropoiesis.
- Kidneys secrete Thrombopoietin necessary for production of platelets.

③ Endocrine function:-

- Kidney secretes-

a) Erythropoietin.
b). Thrombopoietin.
c). Renin.
d). Calcitriol.
e). Prostaglandins.

④. Regulation of Blood-Pressure:-

- Kidney controls the arterial blood-pressure by 2 ways.

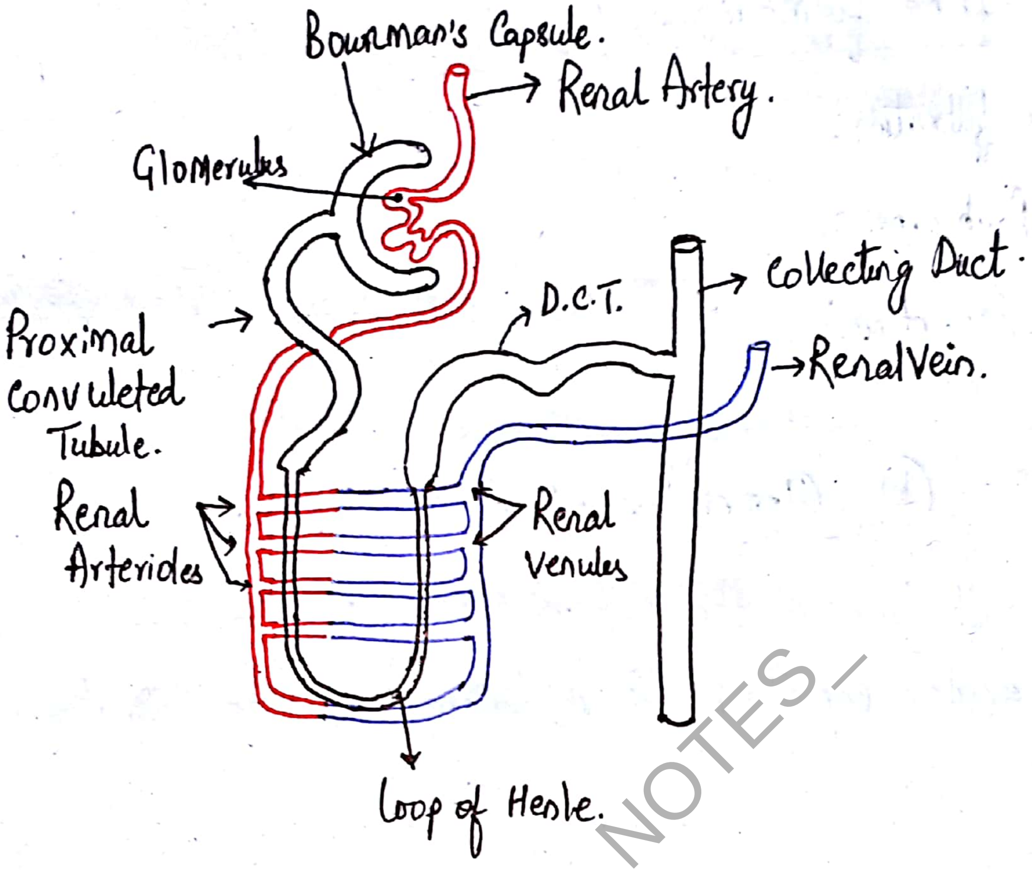
① By Regulating volume of E.C.F.
②. By. Rennin-Angiotensin mechanism.

⑤. Regulation of Blood-Calcium:-

- Kidneys activate Calcitriol into vitamin D.

- Vitamin D is necessary for Calcium absorption from intestine.

→ Mechanism of Urine Formation.→


Bowman's Capsule.
Renal Artery.
Glomerulus
Collecting Duct.
D.C.T.
Renal Vein.
Proximal convuleted Tubule.
Renal Arterioles
Renal Venules
Loop of Henle.

- Urine formation is the blood cleansing function. The metabolic wastes (Ammonia/ Urea) along c̄ excess water are excreted as urine.

Characteristics of Urine

Quantity:– Around 1.4 litre/day./ Colour- Pale yellow.

Constituents:– 91–96% water/ Urea/ chloride/ Sodium/ Pottasium
Creatinine/ Bi- carbonate/ Uric Acid.

PH– 5.5–7 (average of 6.2).

- The Urine formation takes place in the structural & functional unit of Kidneys; i.e. Nephron.

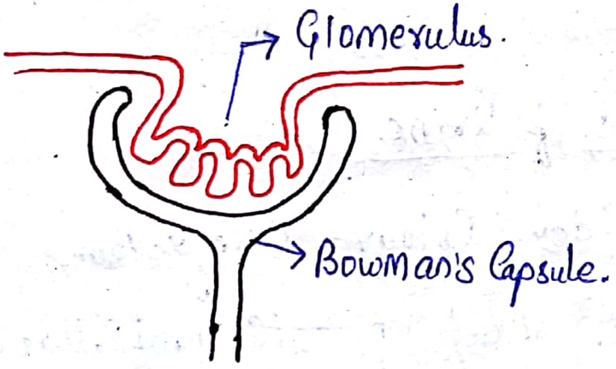
Stages of Urine formation:-

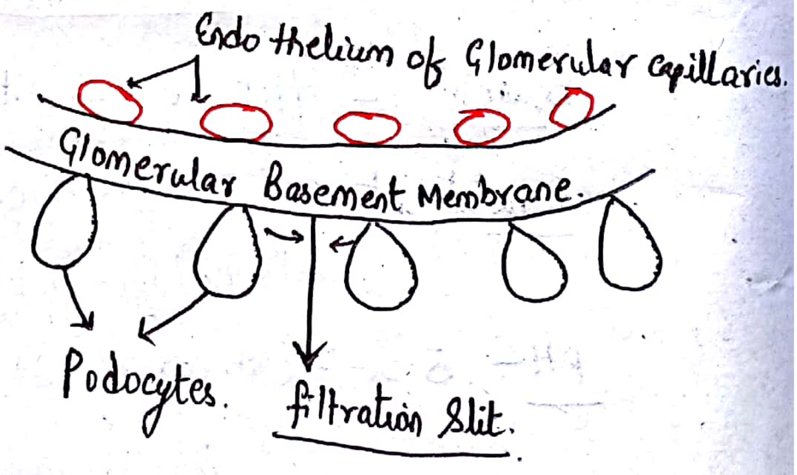
① Glomerular filtration.
② Tubular Reabsorption.
③ Tubular- Secretion.

①. Glomerular Filtration.

- Glomerular filtration is the process by which the blood passes through glomerular capillaries & is filtered by the filtration membrane.

Filtration membrane:-
① Glomerular capillary membrane.
② Basement Membrane.
③. Visceral layer of Bowman's capsule (Podocytes


Glomerulus.
Bowman's Capsule.


Endothelium of Glomerular capillaries.
Glomerular Basement Membrane.
Podocytes.
filtration Slit.

The Blood passes through these 3 layers and is filtered; this process is called ultrafiltration.

All the components of Blood are filtered through these membranes, except Plasma Proteins & the Blood cells (due to their large size).

Glomerular filtration Rate:- (GFR).

- GFR is defined as the total quantity of the filtrate formed in all nephrons of both Kidneys in a given time.

$$\boxed{\text{GFR} = 125\ \text{ml/minute or } 180\ \text{litres/day}}$$

② Tubular Reabsorption / Selective Reabsorption.

- Tubular Reabsorption is the process by which water & other substances are transported from the Renal-Tubules back into the blood.

- The substances to be re-absorbed, move into interstitial fluid of Renal medulla; from here they move back into blood by Peritubular Capillaries.

- The Reabsorption process takes place in.
  - → Proximal Convoluted Tubule.
  - → loop of Henle.
  - → Distal Convoluted Tubule.

① PCT Reabsorption:-

- About 88% of filtrate is Reabsorbed in the PCT.

- Substances Reabsorbed from the PCT are:-

  ①. Glucose
  ②. Amino-Acids.
  ③. Sodium
  ④. Pottasium
  ⑤. Calcium
  ⑥ Bi-Carbonates.
  ⑦ chlorides.
  ⑧ Phosphates
  ⑨. Uric-Acid.
  ⑩. Water.

② loop of Henle Reabsorption:-

① Sodium
②. Chloride.

③ DCT Reabsorption:-

① Sodium.
② Calcium.
③ Bi-Carbonate
④ Water.

③. Tubular- Secretion.

- During Tubular secretion the few substances are Transported from the blood into the Renal-tubules.

- Substances of Tubular Secretion:-

① Para-Amino Hippuric Acid.
②. Drugs
③ Amino derivatives.
④ Penicillin.

Tubular Secretion:-

PCT - Pottasium/ Ammonia/ H+ ions.
DCT - Pottasium/ H+ ions.

Control of Micturition.

- Micturition is the process by which urine is voided from the urinary Bladder.
- Micturition is a Reflex process, however it can be controlled voluntarily upto some extent.

Micturition Reflex.

Filling of Urinary Bladder.

↓

Stimulation of stretch Receptors

↓

Afferent impulse via Pelvic Nerve (S_2, S_3, S_4).

↓

Efferent impulse via Pelvic Nerve.

↓

Detrusor Muscle – Contracts.

Internal sphincter – Relaxes

↓

Urine flows upto Urethera

↓

Stimulation of Stretch Receptors

↓

Afferent fibres via Pelvic Nerve

↓

Inhibition of Pudendal Nerve

↓

Relaxation of External sphincter

↓

Micturition.

- Formation of faeces -

Undigested food comes from ileum into the colon, consists of indigestable materials & liquid.

↓

Undigested food goes through Ascending colon → Transverse colon → Descending colon.

↓

Water, Salt & Vitamins are absorbed into the colon, and the Remaining contents in the lumen becomes faeces.

Composition of faeces.

- 75% water.
- 25% Solids.
  - Inorganic
    - Calcium phosphate.
    - Iron phosphate.
    - Intestinal Secretions
    - Epithelial cells
    - Mucus.
  - Organic
    - Bacterial Biomass
    - Protein waste
    - Carbohydrate (Cellulose)
    - fats.

-Mechanism of Defecation-

The Act of defecation is an reflex process called Defecation Reflex.

- The defecation Reflex is composed of-

① Intrinsic- defecation Reflex- Carried by ENS/ weak in Nature.

② Parasympathetic defecation Reflex- Carried by ANS/ Strong " "

- Intrinsic Defecation Reflex-

Faeces enters the Rectum

↓

Distention of Rectal wall

↓

Stimulation of Stretch Receptors.

↓

Sensory fibres Reaching myenteric plexus.

↓

Motor Signals to smooth muscles of Descending colon, Sigmoid colon, Rectum

↓

Peristaltic wave formation.

↓

Pushes faeces towards Rectum

↓

Relaxation of Internal Anal Sphincter.

Para Sympathetic Defecation Reflex.

Faeces enter the Rectum

↓

Distention of Rectal wall.

↓

Stretch Receptors in Rectal wall

↓

Sensory fibres to S_2-S_4 spinal segments.

↓

Pelvic Para Sympathetic Nerves.

↓

Strong Peristaltic waves in the Descending colon, Sigmoid colon, Rectum

↓

- Faeces pushed towards Rectum
- Relaxation of Internal Anal sphincter.

Act of Defecation.

- Combination of Intrinsic & Parasympathetic Defecation Reflex.

↓

- Closure of Glottis
- Deep Inspiration
- Abdominal Contraction.

↓

- Inhibition of external Anal Sphincter (Voluntary). via Pudendal Nerve

↓

Defecation.

Unit. 9. Endocrine Glands.

- General Introduction to Endocrine System. ✓
- Classification & characteristics of Hormones. ✓
- Physiology of all Endocrine Glands; their functions & effects.

① Introduction of Endocrine System.

- The endocrine system is a chemical messenger system consisting of Hormones, the group of glands of an organism that carry those hormones directly into the circulatory system; to be carried towards distant organs.

Endocrine - Glands.

- Endocrine glands are the glands, which produce and release the hormones, into the blood.
- Endocrine glands are also called Ductless glands.

Major Endocrine Glands.

① Pituitary Gland.
② Pineal Gland.
③ Thyroid Gland.
④ Para-thyroid glands.
⑤ Thymus
⑥ Adrenal
⑦ Pancreas.
⑧ Ovary (♀).
⑨ Testis (♂).

② Classification & Characteristics of Hormones.

Definition:- A Hormone is defined as a chemical messenger Synthesized by endocrine glands & transported by blood to the Target Organ/ Tissue.

Characteristics of Hormones.

① Hormones are produced from special cells of endocrine glands.

②. They are transported to the target cell/ Tissue/ Organ by circulation.

③. Hormones are specific in action.

④. Hormones are active in very little quantities.

⑤ Hormones are mostly water soluble.

⑥. Hormones are having low moleculear weight.

⑦ They are destroyed after their actions.

⑧ Hormones can not be stored for long time.

⑨. Hormones act by making Hormone- Receptor Complex.

– Classification of Hormones –

A). On the Basis of chemical Nature:–

① Steroid Hormones:–

- Hormones formed by cholestrol/ it's derivatives.
- Secreted from Adrenal Cortex, Gonads, Placenta.

② Protein Hormones:–

- Hormones formed by peptides.
- Secreted from Pituitary, Para-thyroid, Pancreas, Placenta.

③. Tyrosine Derivatives:–

- Hormones derived from amino-acid Tyrosine.
- Secreted from Thyroid & Adrenal medulla.

Steroids	Proteins.	Tyrosine Derivatives.
∘ Aldosterone.	∘ GH	∘ T_3
∘ Cortisol.	∘ TSH	∘ T_4
∘ Corticosterone	∘ ACTH	∘ Adrenaline
∘ Testosterone.	∘ FSH.	∘ Nor-Adrenaline.
∘ Dihydrotestosterone.	∘ LH.	∘ Dopamine.
∘ Estrogen	∘ Prolactin.	
∘ Progesterone.	∘ ADH	
	∘ Oxytocin.	
	∘ PTH	
	∘ Calcitonin.	
	∘ Insulin.	
	∘ Glucagon.	
	∘ HcG.	

③ Physiology of All Endocrine Glands, Functions, Effect

① Pituitary Gland (पीयूष ग्रन्थि).

Introduction:-

Pituitary gland/hypophysis is a small gland of 1 cm diameter and weight of 0.5-1 gm. It is connected c̄ hypothalamus by hypophyseal stalk.

- Physiologically, it can be divided into 2 parts.
  ① Anterior- Pituitary / Adenohypophysis.
  ② Posterior- pituitary. / Neurohypophysis.

Hormones of Pituitary Gland.

Anterior Pituitary

- → Growth Hormone (GH).
- → Thyroid stimulating Hormone (TSH).
- → Adrenocorticotropic Hormone (ACTH).
- → follicle - stimulating Hormone (FSH).
- → Lutenising Hormone (LH)/ Intersitial cell stimulating Hormone (ICSH).
- → Prolactin.

Post. pituitary.

- → Anti- diuretic Hormone (ADH).
- → Oxytocin.

① Growth Hormone. (GH).

Secreted from – Somatotrope cells of Ant. pituitary.

Blood level:– 300 ng/dL → Adult / 500ng/dL → children.

Daily Output:– 0.5–1.0 mg / day.

Actions.

① General functions:–

- Growth of all Body Tissues.
- Increases the size & number of cells.
- Responsible for general body growth.

② Protein Metabolism:–

- GH increases the protein synthesis by,

1). Increase of Amino Acid Transport through the cell membrane.

2). Activates the Ribosomes to produce more proteins.

3). Accelerates the Transcription of DNA to RNA.

4). Decreases the Break down of cellular protein.

③ On lipid Metabolism:-

- GH mobilises fats from Adipose Tissues; thus the concentration of fatty acids is increased in Body fluids.

④ On Carbohydrate Metabolism:-

- Main Action of GH on Carbohydrates is Conservation of Glucose
- It decreases peripheral utilisation of glucose.
- Increases glycogen deposit in the cells.
- Increases blood glucose levels.

⑤ On Bones:-

- In embryonic stage, GH is Responsible for the differentiation & development of Bone cells.
- It increases the length of Bones.
- After puberty, when the epiphysis of bone [growing end of bone] fuses c̄ the shaft, GH increases the thickness of Bones.

Control of GH.

- GH Secretion is controlled by Hypothalamus. by 3 Hormones:

① Growth Hormone Releasing Hormone (GHRH).

- Increases the Secretion of GH from Ant. pituitary.

② Growth Hormone Releasing Polypeptide (GHRP).

- Promotes the Secretion of GHRH from Hypothalamus & GH from Ant. pituitary.

③ Growth Hormone Inhibitory Hormone. (GHIH) / Somatostatin.

- Inhibits the Secretion of GH.

Hyper-Secretion of GH.

Gigantism.	Acromegaly.
○ Hyper Secretion of GH during child hood.	○ Hyper secretion of GH after puberty; after fusion of epiphysis c̄ the shaft of the Bone.
C/F- ① Height 7-8 feet. ② Disproportional long limbs. ③. Hyperglycemia ④ Diabetes. ⑤. Constant Headache. ⑥ Visual disturbances, due to compression of optic- chiasma.	C/F- ① Protusion of Supra- orbital Ridges. ② Broad Nose. Thick lips, ③ Protusion of lower jaw. ④. Guerrila face. ⑤ Enlarged limbs. ⑥ Bent spine i.e. Kyphosis. ⑦. Wrinkles on forehead ⑧. Hyperglycemia. ⑨. Headache ⑩. Visual - disturbances.

– Hypo-Secretion of GH –

① **Dwarfism:–** Hypo Secretion of GH Resulting in stunted Growth.

C/F–
① Maximum Height 3 feet.
② Slightly larger Head.
③. No Mental Retardation.
④. Normal Reproductive functions.

②. **Acromicria:–** Hyposecretion of GH in adults.

- Atrophy & Thinning of extremities.
- Lethargy & obesity
- Loss of Sexual functions.

---

② Thyroid Stimulating Hormone (TSH).

- TSH is secreted from Ant. pituitary, is the major function regulating the synthesis & Release of thyroid Hormones.
- TSH is also necessary for Growth & secretion of Thyroid Gland.

Normal Levels:– 0.4 – 4.0 mili International units/ litre.

Actions of TSH.

① TSH increases the number of Thyroid cells.
② TSH increases the size & secretion of thyroid-cells.
③. TSH increases the Thyroglobulin secretion.
④. Proteolysis of Thyroglobulin to Release Thyroxin.

Control of TSH.

- TSH is controlled by Thyrotropic Releasing Hormone (TRH) of Hypothalamus.

Hyper Secretion of TSH.

- Results in Hypo-Thyroidism.

Hypo Secretion of TSH.

- Results in Hyper-thyroidism.

③. Adreno Cortico Tropic Hormone (ACTH).

- ACTH Secreted from Ant. pituitary controls the activities of Adrenal Cortex.
- ACTH is mainly concerned c̄ Cortisol Secretion.

Normal levels – 3 ng/dL

Actions:–

① Maintains the structure & vascularity of Adrenal cortex.

② Converts cholestrol into pregnenolone, which forms Gluco-corticoids.

③ Release of Gluco-corticoids.

④ Mobilisation of fat from tissues.

⑤. Darkening of skin, by acting on melanin-cells.

Control of ACTH.

- ACTH is controlled by Corticotropin Releasing factor [CRF] Released from, Hypothalamus.

Hyper-Secretion

① Cushing's disease.

↑ ACTH → ↑ gluco-corticoids

Hypo-Secretion.

① Hypoadrenalism.

Follicle-Stimulating Hormone.

- FSH is Secreted from Ant. pituitary & is having following functions.

① **In Males** –

FSH acts c̄ Testosterone & accelerates the process of Spermeogenesis. (maturation of sperms).

② **In females** :–

① FSH is Responsible for devlopment of Graffian follicle from primordial follicle.

② Stimulates the secretion of estrogen from graffian follicle

Lutenising Hormone (♀) / Interstitial cell stimulating Hormone (ICSH) (♂).

① **Action in Males** –

- Stimulates the leydig cells in Testis to produce Testosterone.

② **Action in females** :–

① Maturation of Vesicular follicle into Graffian follicle.

②. Responsible for ovulation.

③. Necessary for formation of corpus-luteum.

④. Activates the secretions of corpus-luteum.

- Posterior- Pituitary Hormones -

① Anti- Diuretic Hormone (ADH).

- ADH is secreted from supra-optic nucleus of Hypothalamus & is stored in post. pituitary.

Actions:-

① Main Action of ADH is water- Retention by acting on Kidneys.

②. Increases Reabsorption of water from D.C.T & collecting duct of Nephron.

③ ADH shows vaso-constriction property on Arteries.

Control of ADH Secretion.

① Decrease of E.C.F Volume in Body.

② Increase of osmolar concentration in the E.C.F.

② OxyTocin.

- Oxytocin is produced by Paraventricular nucleus of Hypothalamus and is stored in post. pituitary.
- Oxytocin is produced in male & female Both.

Actions:-

① Oxytocin is Responsible for ejection of milk from breasts by milk-ejection Reflex.

② Oxytocin causes contraction of pregnant uterus resulting in expulsion of fetus.

③. Oxytocin causes uterine contractions during sexual intercourse to help sperms to reach the uterus.

④. In males, oxytocin facilitates the release of sperm in urethra by contraction production in vas-deferens during sexual-intercourse.

Hyper Activity of Post. Pituitary.

① Syndrome of Inappropriate Hypersecretion of Anti-diuretic Hormone (SIADH).

- Excessive loss of Sodium through urine due to Hyper-secretion of ADH.

C/F - ① loss of appatite.
② Weight loss.
③ Nausea & Vomitting.
④ Headache
⑤ Muscle-weakness.
⑥ fatigue.

Hypo Activity of Post. pituitary.

① Diabetes-Insipidus –

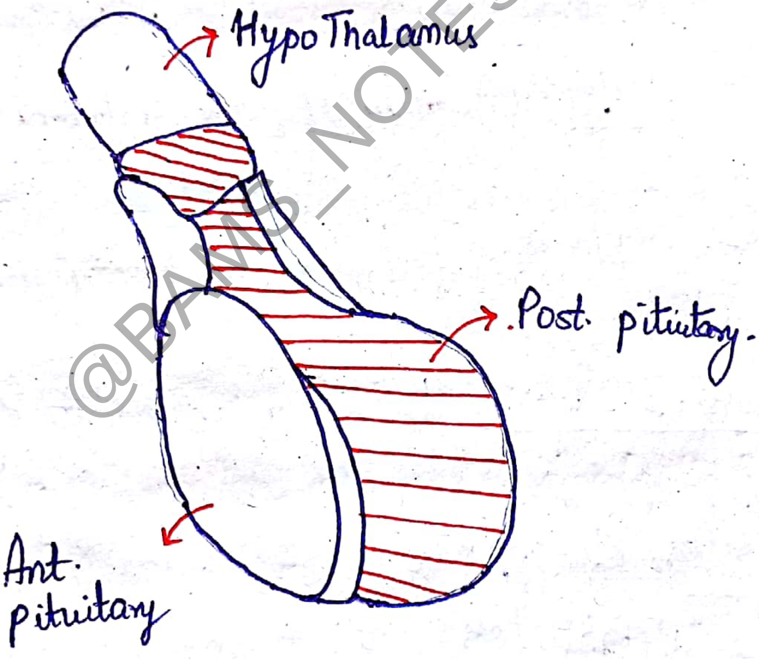
- caused due to ↓ secretion of ADH.

C/F – ① Polyuria:– daily urine output becomes 4-12 litres.

② Polydypsia – Increased thirst.

③ Dehydration.

Blood Tests – ↑ Sodium | ↑ Blood-glucose.


HypoThalamus
Post. pituitary.
Ant. pituitary

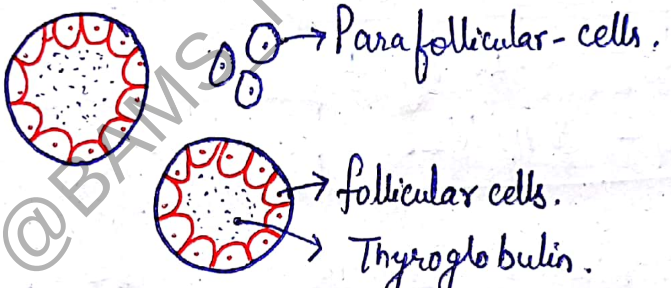
②

Thyroid - Gland.

Introduction:-

- Thyroid is an endocrine gland, situated at the root of the Neck on either side of Trachea.
- It is having 2 lobes, connected by isthumus.
- Normal weight - 20-40 grams in adults.
- Thyroid in females are slightly larger than in males.

Histology:-


Parafollicular-cells.
follicular cells.
Thyroglobulin.

- Thyroid gland is composed of large number of closed follicles.
- These follicles are made up of follicular cells.
- The follicular cavity is filled c̄ colloidal substance called Thyroglobulin.
- In b/w the follicular cells, parafollicular cells are present.

Thyroid Hormones.

①. Tetra-iodo thyronine / Thyroxin → T_4.
②. Tri- iodo thyronine → T_4
} follicular cells.

③. Calcitonin. → Parafollicular- cells.

- T_4 is 90% of Total secretion & T_3 is 9-10%.
- T_3 is 4 times more potent than T_4.
- T_3 - Quick Action & less duration.
- T_4 - Slow Action & longer duration.
- Iodine is Necessary for formation of T_3 & T_4.
- Normal plasma levels.

T_3 - 0.12 μg/dL.
T_4 - 8 μg/dL.

- Control of Thyroid Hormones -

- Thyroid gland functions are under direct effect of TSH from Ant. pituitary.

Function of Thyroid Hormones.

System	Action.
On Basal Meta-Bolic Rate.	◦ T_4 increases the metabolic activities of almost all tissues of Body. ◦ ↑ O_2 consumption of Tissues. ◦ ↑ The Rate of utilization of food stuffs.
On Protein Metabolism:-	◦ ↑ The protein synthesis in cells.
On Carbohydrate Metabolism:-	• ↑ the glucose Absorption from GIT. • ↑ the Breakdown of glycogen into glucose. • ↑ Gluconeogenesis.
On fat metabolism.	• Converts the fats in free fatty Acids. • ↓ the fat storage.
On Plasma & liver fats.	◦ ↓ cholestrol, phospholipids & TG. levels in blood. ◦ ↑ Fat deposition to the liver.
On Body Temp.	↑ Heat production in body.
On Growth:-	• Promotes growth & devlopment of Brain during fetal life.
On Blood -	• ↑ the formation of RBCs.
On CVS:-	• ↑ Heart Rate, ↑ Contraction of Heart. / ↑ Systolic B.P.
On Respiratory System.	• ↑ the Rate & force of Respiration.
On G.I.T.	• ↑ Appetite & food intake.
On C.N.S.	• Promotes Growth & devlopment of Brain during fetal life. • ↑ Blood flow to Brain.
On Sleep.	◦ Hyper Secretion of T_4 → Tierdness & sleepiness, but patient can not sleep.

Hyper-Secretion. (Hyper-Thyroidism).

- Increased Secretion of Thyroid Hormones is called as Hyperthyroidism.

- **Cause:-** ① **Grave's disease:-**

  - It is an auto immune disease & most common cause of Hyper-thyroidism.
  - In Normal Conditions.-

    TSH → Receptor Cells of Thyroid → Production of T_3, T_4.

  - In Grave's disease:-

    - B lymphocytes produce → Thyroid stimulating Auto-antibodies (TSAB).
      ↓
      Works as TSH for longer duration → Excessive T_3, T_4 production → HyperThyroidism

Clinical features:-

① Intolerance to Heat due to increased B.M.R.

② Increased sweating.

③ Decreased Body weight due to fat mobilization.

④ Increased motility of GIT causing diarrhea.

⑤ Muscular weakness

⑥ Hyper excitability, Tremors, Anxiety due to hyper stimulation of Neurons.

⑦ Toxic Goitre (Enlarged Thyroid).

⑧ Exopthalamos, due to oedema of Retro-orbital tissues & degeneration of extra-ocular muscles.

Hypo- Thyroidism.

- Decreased Secretion of Thyroid Hormones is called as Hypo-Thyroidism.
- It leads to myxedema in adults & Cretinism in children.

① Myxedema.

Causes:- ① disease of Thyroid gland.
② Genetic disorder.
③ Iodine deficiency.
④ Deficiency of TSH.

C/F:- ① Swelling of face.
②. Bagginess under eyes.
③. Non- pitting oedema due to protein accumulation.
④. Atherosclerosis - Hardening of Arteries due to fat deposition in Arteries.

Other General features of Hypothyroidism.

① Anemia
② Fatigue
③ Hypersomnia.
④. menorrhagia / Polymenorrhea.
⑤ Decrease HR
⑥ Increased Body weight.
⑦ Constipation.
⑧ Depressed Hair Growth.
⑨ Cold- intolerance.

② Cretinism.

- Hypo-Secretion of Thyroid Hormones leading to stunted Growth.

Causes:-
- Congenital Abscence of Thyroid;
- lack of iodine in diet.
- Genetic disorders.

C/F:-
① Clinical features develop few weeks after Birth.
②. Sluggish movements
③ Croaking sound.
④ Stunted growth c̄ Bloated Body.
⑤ Big enlarged Tongue
⑥ Mental Retardation.
⑦ Disproportinate Body parts.

Goiter (घेंघा रोग).

- Goiter means enlargement of Thyroid Gland. It occurs both in Hypo-thyroidism & Hyper-thyroidism.

Goiter in Hyper-Thyroidism:- Toxic-Goiter.

- Toxic goiter is the enlargement of the thyroid gland with increased secretion of Thyroid Hormones caused by Thyroid Tumor.
- This type of goiter is seen in Grave's disease.

Goitre in Hypo-Thyroidism.

① Endemic Colloid Goiter:-

This type of goiter is caused by Iodine deficiency. When iodine intake is less than 50µg/day, there is no formation of Hormones.

Due to lack of Hormones; the TSH secretion is increased from Ant. pituitary, causing excessive formation of Thyroglobulin into the thyroid follicle, resulting in swelling of thyroid gland.

Calcitonin:-

- Calcitonin is secreted from parafollicular cells of thyroid glands.

Actions:-

Calcitonin participates in Calcium & Phosphorus metabolism.

○ Calcitonin lowers blood Calcium levels by.

- Inhibiting ~~osteobl~~ osteoclast activity.
- Inhibits Re-absorption of Calcium & phosphate from kidneys.

③ Para-Thyroid Gland.

Introduction:-

- In Human, there are 4 parathyroid glands, located immediately behind thyroid gland.
- Size- 6mm long x 3mm wide x 2mm Thick.

Hormone:- The chief cells of Parathyroid glands secrete Parathyroid Gland's main Hormone "Parathormone". (PTH).

Normal Plasma levels:- $\boxed{1.5-5.5\ ng/dL}$.

Actions.

① On Blood-Calcium level:-

- PTH maintains the blood Calcium level with range of 9-11 mg/dL.
- PTH increases:-

① Reabsorption of Calcium from the Bones.
② Reabsorption of Calcium from Renal tubules.
③ Absorption of Calcium from GIT.

② On Blood Phosphate level:-

- PTH decreases blood phosphate levels; it stimulates the phosphate resorption from Bone; and increases the phosphate Urinary excretion.

③ On Bone:-

- PTH stimulates the osteoclast cells activity.
- PTH makes the bones to release Calcium into the Blood.

④ On Kidneys:-

- PTH stimulates Reabsorption of Calcium from Kidneys.
- PTH increases the formation of Vit. D in Kidneys.

⑤ On G.I.T:-

- PTH increases the absorption of Calcium from GIT directly.

Hypo-Parathyroidism (Hypo-Calcemia).

- Decreased secretion of PTH is called Hypo-parathyroidism.

Causes:-

① Surgical Removal of Parathyroid.
②. Auto-immune disease.
③. PTH Receptor deficiency on Target cells.

Main Effect:-

Hypothyroidism causes Hypocalcemia; (decreased plasma Calcium level); by decreasing the Reabsorption of Calcium from Bones.

Hypocalcemic- Tetany.

- Tetany is an abnormal condition characterised by hyper exictability of Nerves & Skeletal muscles resulting in painful; muscular spasm.
- It occurs when plasma Calcium level decreases below 6mg/dL.

QF:-

① Convulsive muscular contractions.

② Voilent & painful muscular contraction in hand & feet.

③ Laryngospasm causing Noisy Breathing.

④ Prolonged ST- segment and QT- interval in ECG.

⑤ Hypotension.

⑥ Heart failure.

Hyper- Parathyroidism → Hyper- Calcemia.

- Hyper Secretion of PTH is called Hyper- parathyroidism.

CF-
1. Depression of Nervous- System.
2. Sluggish Reflex- activities.
3. Lack of App atite.
4. Constipation.

- If Blood calcium levels Reaches >17 mg/dL.

  - Excessive Ca^{2+} & PO_4^- makes crystals in blood; and these crystals may deposit in Kidney, Thyroid, lungs, arterial walls.

④ The Pancreas.

Islets of langerhans:-

The endocrine functions of pancreas is carried out by the islets of langerhans (1-2 million) present in pancreas.

Main Hormones -

Cells -	Hormones
α- cells -	Glucagon.
β- cells -	Insulin.
δ- cells -	Somatostatin.

-: INSULIN :-

- Insulin is secreted from β- cells in islets of langerhans of pancreas.

Base level:- 10 μU/mL.

formation:- Insulin is formed in the endoplasmic Reticulum of β- cells.

Preproinsulin ⟶ Pro- Insulin

↓

Insulin.

Actions of Insulin.

Insulin is the only Anti-diabetic Hormone in the Body.

① Effects on Carbohydrate Metabolism:-

- Insulin Reduces blood-sugar level by.

a). facilitating Transport and uptake of glucose by the cells.
b). Increasing peripheral utilization of glucose.
c). Increases conversion of glucose into glycogen.
d). Inhibits glycogenolysis.

②. Effects on Protein Metabolism.

- facilitates synthesis & storage of protein & inhibits the cellular utilisation of proteins.
- increases the permeability of cell membrane for Amino-acids.
- increases the storage of protein in Body.

③ Effects on Fat metabolism:-

- Transports excess glucose into liver cells to Control them into fatty Acids & Tri-glycerides.

Insulin levels fluctuation.

Blood sugar levels ↑ after meals.

↓

c̄ in few minutes the Insulin reaches 100 µU/ml from 10µU/~~litre~~ml.

(Insulin stored in Pancreas).

↓

c̄ in 10 – 15 minutes the Insulin concentration falls to 40-50 µU/ml.

↓

After 15-20 minutes Insulin level ↑ again Slowly but steadily; The maximum insulin levels are obtained after 2-2½ Hours of meal.

(New, insulin molecules from pancreas).

— Glucagon —

- Glucagon, is secreted from α-cells in islets of Langerhans.

Actions—

① On Carbohydrate Metabolism:—

- ↑ Blood-glucose level.
- ↑ Glucogenolysis (Converts Glycogen → Glucose).
- Formation of glucose. from Amino-acids & fats.

②. On Protein Metabolism:—

- ↑ Transport of Amino-acids into liver.
- Amino-acids are utilised for glucose formation.

③ On fat metabolism:—

- lipolytic actions.
- Promotes Ketogenesis.

④ other:—

①. ↓ Secretion of Gastric juice.

②. ↓ Secretion of Bile from Liver.

— Somatostatin —

Secreted from —

① Hypo Thalamus.
② δ- cells in Islet of Langerhans.
③. Stomach & upper part of Intestine.

Actions :→

① Inhibits the secretion of both glucagon & insulin.
② decreases the motility of stomach, duodenum & gall Bladder.
③ ↓ Secretion of GH/TSH from ant. pituitary.

Hypo Activity of Insulin → Diabetes-mellitus.

Introduction:- D.M is a metabolic-disorder characterised by High Blood-Sugar levels; c̄ other manifestations.

Types:-

Features.	Type-I (IDDM).	Type-II (NIDDM)
Age of Onset.	Before 40 years.	After 40 years.
Major. Cause.	Lack of Insulin.	Lack of Insulin Receptor.
Insulin Deficiency.	✓	Partial deficiency.
Destruction of β- cells.	✓	X
Involvement of other Endocrine Diseases.	X	✓
Herediatary.	✓	may/may not
Need for Insulin.	✓	May Require in later stage.
Insulin Resistance.	X	✓
Control by Oral- Hypoglycemic Drugs.	X	✓
Symptoms Appear.	Rapid	Slow.
Body weight.	Thin.	Over Weight.
Stress Induced obesity.	X	✓
Ketosis.	✓	May/maynot

Causes of Type-1. D.M.

- Also called Insulin dependent Diabetes mellitus. (IDDM).
- Deficiency of Insulin.
- Dysfunction/ Absence of β- cells.
- when occurs in infancy, called Juvenile diabetes.

Causes of Type-II. D.M.

- Also called Non- Insulin Dependent Diabetes mellitus [NIDDM].
- decreased/ absent Insulin Receptors in body cells.
- Usually occurs after 40 years.

-Clinical features-

① Increased Blood Sugar levels (300- 400 mg/dL).

②. Mobilization of fat from Adipose Tissue, for energy purpose. → ↑ fatty Acids in Blood → Atherosclerosis.

③ Protein depletion from tissues.

① Glucosuria:-

- Presence of glucose in Urine.
- Glucose is present in Urine, only when Blood Sugar level > 180 mg/dL.

② Osmotic- Diuresis.

- Excessive formation of urine due to excessive blood glucose.
- ↑ Blood glucose → Reabsorption of water from Renal Tubules → Osmotic diuresis.

③ Polyuria:-

- ↑ Urination.

④ Poly dypsia:-

- ↑ Urination → ↓ water content in Body → Stimulation of Thirst centres in Hypo Thalamus → Poly dypsia.

⑤ Polyphagia:- ↑ intake of food.

⑥ Asthenia:- ↓ insulin → ↓ Protein Synthesis, ↑ Protein Breakdown → loss of Strength in Body (Asthenia).

⑦ Acidosis:- ↓ Insulin → ↓ Glucose utilization → fats are used for energy purpose → Break down of fats produces Ketoacids. → ↑ Acid production in Body.

⑧ Acetone Breathing- ↑ Ketoacid formation →

Complications.

① Hyper-Tension
②. Myocardial-Infarction.
③. Diabetic Retinopathy.
④. Diabetic Nephropathy.
⑤. Diabetic Neuropathy.

Diagnostic- Tests for D.M.

1. Fasting Blood Sugar.
2. PPBS.
3. Glucose Tolerance Test (GTT).
4. HbA1C.

Normal Blood- Sugar levels.

① **Fasting Blood Sugar (F.B.S):-**

- ↓100mg/dL (70-100) — Normal.
- 100-125 mg/dL — Prediabetes
- > 126 mg/dL — Diabetes.

② **Post- prandial Blood Sugar:- (PPBS):-**

- ↓140 mg/dL → Normal.
- 140-199 mg/dL → Pre- Diabetes.

③ **Random Blood Sugar:- (RBS)**

- ↓ 200mg/dL.

Adrenal Gland.

- The adrenal glands are also called as 'Supra-Renal Glands'.
- Adrenal glands are also known by names of
  - 1). life-Saving Glands.
  - 2). The essential endocrine Glands.

- The Adrenal glands are wedge shaped glands situated above kidneys, and weight about 4 grams.

- Parts of Adrenal:-
  ① Adrenal Cortex- Outer 80% part.
  ② Adrenal Medulla- inner 20% part.

Adrenal Cortex.

- The Adrenal Cortex is formed by 3 layers of structures.
  ① Zona-glomerulosa- Outer layer.
  ② Zona-fasciculata- Middle layer.
  ③. Zona-reticularis- Inner layer.

Adrenal Cortex Hormones:-

- Adrenal Cortex Hormones are called as Adreno cortical Hormones or Cortico- Steroids.
- Based upon functions, the Corticosteroids are divided into 3 groups.

Cortico Steroids.

- Mineralo- Corticoids.
  - Aldosterone (90%).
  - 11- Deoxy Corticosterone. (10%).
- Gluco- Corticoids.
  - Cortisol (95%)
  - Corticosterone.(4%)
  - Cortisone.(1%).
- Sex-Hormones.
  - Dehydroepiandrosterone.
  - Androstenedione.
  - Testosterone.

① Mineralo Corticoids:-

- Mineralo corticoids are steroids in Nature, and are Synthesized from cholestrol.

- Mineralo corticoids mainly act on the minerals(electrolytes) particularly Sodium & Potassium.

- There are 2 mineralo corticoids.
  ① Aldosterone
  ② . 11- Deoxy corticosterone.

Source:- Mineralo corticoids are secreted from Zona glomerulosa. of Adrenal cortex.

Functions of Mineralo corticoids.

① Life- Saving Hormones:- Aldosterone is very essential Hormone for life & total loss of Corticosteroids. can cause death c̄ in 3 days - 2 weeks.

- The deficiency of Aldosterone causes 3 conditions.

1). Excessive Increase of Pottasium ions in E.C.F. (Hyperkalemia)

2). Excessive loss of Sodium ions (Hyponatremia).

3). Decreased Blood volume; → Cardiac Arythmia → Shock → Death.

Functions of Aldosterone:-

① It increases the Reabsorption of Sodium ions from Renal Tubules.

② It increases the excretion of Pottasium ions from the Renal Tubules.

③. It increases the Secretion of H^+ ions into the tubules.

Effect on ECF/ Blood Volume:-

- Aldosterone increases the Reabsorption of Na^+ from Renal tubules, and water (H_2O) is also reabsorbed c̄ Na^+ to maintain blood sodium levels.

- So; ↓ Aldosterone
↓
↓ Na^+ Reabsorption
↓
↓ Water "
↓
↓ Blood Volume.

Effect on B.P:-

Aldosterone Increases the blood volume & thus increases the blood pressure.

Regulation of Mineralocorticoids.

The Secretion of Aldosterone; occurs when there is –

① High Pottasium levels in ECF.
② Low Sodium levels in ECF.
③. Decreased ECF Volume.
④. Under control of ACTH.

---

② Gluco-Corticoids.

- Glucocorticoids are the Corticosteroids acting on Glucose metabolism.

  1. Cortisol. (95%) – Most potent.
  2. Corticosterone. (04%)
  3. Cortisone. (01%).

Secretion:– Gluco-corticoids are secreted from Zona fasciculata.

Life-Protecting Hormone:–
- Cortisol is called life protecting Hormone as it helps to withstand the stress & Trauma in life.
- However, Anti-stress mechanism of Cortisol is not properly understood yet.

Actions:-

① On Carbohydrate Metabolism.

(1) Gluco- Corticoids increase the blood glucose level by

ⓐ promoting gluconeogenesis. into liver from Amino-Acids.

ⓑ By preventing glucose uptake & utilisation into peripheral tissues. (Anti- Insulin Action).

- ↑ Secretion of Gluco corticoids - Adrenal diabetes.
- ↓ Secretion of Gluco corticoids - Hypoglycemia.

② On Protein Metabolism:-

- Gluco- Corticoids promote Protein Catabolism.
- Gluco- Corticoids decrease protein synthesis in all body tissues except liver.
- Gluco- corticoids breaks down proteins to form Amino- Acids.
- Gluco- corticoids increase the transport of Amino Acids from body tissues to the liver.

③. Fat Metabolism:-

- Gluco- corticoids mobilise the fats from Adipose Tissue → Blood.
- Gluco- corticoids ↑ the utilisation of fat for energy.

④ Water metabolism:-

- Gluco Corticoids accelerate water excretion when large quantity of water is present in Body.

⑤ On Blood - Cells:-

- Gluco- Corticoids decrease the number of
  ① Eosinophils → ↑ destruction in liver.
  ② T- lymphocytes → Supresses lymphoid tissues.

⑥ Anti- Inflamatory Action:-

· Gluco corticoids show Anti- inflamatory actions by -

① Preventing secretion of proteolytic enzymes.
② Vaso constriction.
③ ↓ Numbers of T- lymphocytes.
④ ↓ Migration of WBCs to site of inflamation.

⑦ Immuno Compressive Actions:-

③. Adrenal Sex Hormones.

- Adrenal Sex Hormones are Secreted from Zona- Reticularis.
- It mainly secretes Androgens & Small quantity of estrogen & progesterone.

① Dehydro epi androsterone. — Most affective.

②. Androstenedione.

③. Testosterone.

functions.

① Devlopment of masculine Body features.

Exogenous Steroids.

① Cortisone/ Hydro- Cortisone: — Gluco corticoid+ Mineralo corticoid.

②. Predinsolone. > Gluco corticoid
↓ Mineralo corticoid.

③. Flu dro cortisone: — > Mineralo corticoid.

④ Dexamethasone— only Gluco- corticoid.